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INTERNATIONAL INSTITUTE FOR THE CONSERVATION OF MUSEUM OBJECTS

THE incorporation as a company under English law by the Board of Trade is announced of the International Institute for the Conservation of Museum Objects. It is a professional body formed for the purpose of setting and maintaining a high standard of skill and competence in the conservation of all kinds of valuable material and artistic patrimony.

The problem of conservation is constantly in the minds of those responsible for the safe custody of national treasures in museums and art galleries. It presents many difficulties, some of which seem almost insurmountable under normal variations of climatic conditions such as variations of temperature, humidity and dust content of the atmosphere. These variations may produce in some cases a state of progressive deterioration which, in view of the large number of objects involved and the comparatively few experienced workers available for the work, may not be checked before irretrievable damage is done.

Conservation came much into prominence during the War, when it became necessary to find suitable sanctuary for art treasures. In Great Britain, as in countries on the Continent, these treasures were housed under conditions which in some cases approached the ideal, and it was found, happily, that many of the ailments to which objects of art are subject disappeared. Owing to the excellent arrangements made in Britain during the War for the housing of the nation's pictures, over the whole period from 1940 until 1945 no new cases of cracking, warping, blistering or flaking were observed, while the pictures, which had been suffering of recent years, ceased after a year or two to require attention. The main reason for this was that it was possible to exercise scientific control over the factors that mattered, chief of these in the case of paintings being temperature and humidity. The knowledge gained during this period was of great value in enabling those responsible for the safety and conservation of these precious objects to decide more definitely the most favourable conditions to strive for when it should become possible to exhibit them again, and the most effective methods to adopt in order to eliminate so far as possible the effects of variation of the factors mentioned.

The complexity of the structure of a work of art such as a painting is realized only by a few. So complex is it, indeed, that the object should be handled by a person who not only has a keen appreciation of art, but who also has had extensive training—specialized training—under the direct supervision of an expert. In addition, it is necessary that he should have had a broad scientific training, as the problems involved are varied and cover a wide field demanding a sound knowledge of the fundamental principles of several branches of science. Furthermore, conservation requires patience, acute observation and sound judgment of those concerned with it.

It is not surprising, therefore, that the number of suitably trained persons falls far short of the demand, and that it is felt there should be some organisation the aim of which should be to encourage and help in the training of suitable persons for this difficult and important task.

One great drawback to progress in conservation has been that there is no commonly accepted standard of attainment upon which due reliance can be placed, or which, once accepted, could be held to discourage inferior workmanship and technique. A similar situation has been encountered in other fields; for example, some years ago in the field of medical radiology the X-ray treatment given in one clinic could not be reproduced or compared with that in another clinic even in the same country, and each country had its own particular methods of treatment; there was no common standard to which reference could be made. This state of affairs was remedied by the establishment of an international unit of dosage. The immediate result was rapid progress in technique and in methods of treatment; countries in different parts of the world were brought closer together, they could compare their results, discuss their difficulties and solve their problems by reference to a common basis.

It has now been decided to take a definite step to surmount somewhat similar difficulties in connexion with the conservation of museum objects by establishing a body on a wide international basis capable, in virtue of the standing of its members and the disinterested character of their outlook, of grappling with the intricate problems of conservation and of advancing knowledge of fundamental principles.

The Institute is to have its headquarters in London, one reason for this choice being that Britain forms a natural link between the United States of America and the Continent of Europe. The members will be of two grades—fellows and associates (with the rank of honorary fellow available for persons of outstanding distinction), with annual subscriptions of five pounds and one pound respectively. Elections will in general be in the hands of a membership committee, reinforced by a ballot of the general body of fellows. Fellowship is intended to be restricted to persons technically qualified, though those in positions of high responsibility for the care of precious objects may be admitted. The grade of associate is intended to provide for those who, while interested in the work of the Institute and sympathetic with its objects, do not possess the necessary professional qualifications. A booklet giving full details of the Institute's aims and regulations is in preparation.

The Institute proposes to publish articles from time to time in a form not unlike that provided by "Technical Studies in the Field of the Fine Arts", which was issued from the Fogg Art Museum of Harvard University during the years 1932–42. As time goes on, it is intended to pay particular attention to training in the theory and practice of conservation, and to co-operate with all institutions providing for such instruction.

The Nuffield Foundation has generously agreed to give £500 a year, for five years, to the funds of the Institute, and a number of other contributions have been promised. On the Continent of Europe, much encouragement has been received from the Belgian Government, and by the friendly replies of a number of eminent authorities to a questionnaire requesting their support.

The following are the office-bearers and those nominated to serve on the membership committee until the general meeting of the Institute in 1953: *President*, G. L. Stout, director of the Worcester Art Gallery, Mass. (formerly head of the Department of Conservation and Research, Fogg Art Museum, Harvard University); *Vice-President and Secretary-General*, F. I. G. Rawlins, scientific adviser to the Trustees of the National Gallery, London; *Honorary Treasurer*, H. J. Plenderleith, keeper of the Research Laboratory, British Museum, London. These three will form the management committee. The membership committee will include P. Coremans, head of the Laboratoire Central des Musées de Belgique et des Archives Centrales Iconographiques d'Art National; M. Pease, conservator, Metropolitan Museum of Art, New York; A. van Schendel, curator of paintings, Rijksmuseum, Amsterdam, with the Secretary-General as *ex-officio* member. Dr. Stout and Dr. Coremans, it will be recalled, were assessors of the Weaver Committee which reported on the cleaning of certain pictures in the National Gallery (see *Nature*, **162**, 166; 1948).

The establishment of the Institute will help to bring about that collaboration between experts of different nations and those intimately interested in conservation, which is so desirable and which, in fact, is essential for rapid progress in the attack on the many difficult problems which still remain to be solved. Its first office-bearers are authorities of international reputation in their respective fields, and their association with the Institute at its foundation augurs well for its future.

PHYSICAL METHODS OF ORGANIC CHEMISTRY

Physical Methods of Organic Chemistry
(Technique of Organic Chemistry, Vol. I.) Second completely revised and augmented edition. Editor: Arnold Weissberger. Part 1. Pp. xii+1072. 100s. Part 2. Pp. xi+1073–2096. 100s. (New York and London: Interscience Publishers, Inc., 1949.)

THIS two-volume American treatise, which first appeared in 1945, has already reached its second edition, and this fact alone proves that the compilation edited by Arnold Weissberger has filled an important gap in the shelves of reference libraries.

The reviewer welcomed the first edition somewhat critically (see *Nature*, **157**, 605 and **158**, 288; 1946) as a book very good in parts but on the whole unbalanced. The present edition has far fewer defects. It has increased in size by more than thirty per cent, partly by the addition of five new chapters, and partly by the rewriting and enlarging of those chapters which had not previously done adequate justice to their topics. A great improvement is the

provision of a comprehensive subject index in each volume. Nevertheless "Physical Methods" still remains a compilation which advertises the techniques and equipment of American scientific laboratories and notes far too seldom the important recent work of British and European laboratories. Evidently the American laboratory worker has a much greater preference for complex machine-shop-made instruments than his British counterpart, who still succeeds in achieving an incredibly high degree of accuracy with mock-up equipment of his own design.

Although the volumes are intended primarily to describe experimental techniques for the determination of the properties of organic compounds, the basic scientific principles relating to each type of measurement are always set out with meticulous care. For these theoretical sections alone, this book deserves a prominent place among modern scientific handbooks. Many chapters, too, conclude with valuable critical estimates of the scope, accuracy and limitations of the experimental procedures which they have described.

Chapters 1 and 2, by J. M. Sturtevant, on temperature measurement and temperature control, are new and quite useful, though the second is not comprehensive enough. It would appear that the convenient method of using bimetallic junctions in vacuum switches has not yet become generally known in the United States. The same contributor's long Chapter 14 on calorimetry is but little altered. Chapters 3 and 4, on the determinations of melting and boiling points, were comprehensive in the first edition. The main improvements noted are the additions of a good account of the useful Menzies–Wright boiling-point apparatus, and of a valuable guide to the selection of experimental methods.

Chapter 5, on the determination of vapour pressure, by G. W. Thompson, is a new 110-page article of first-rate value throughout. It treats excellently methods for computing desired information from limited experimental data.

The chapters on the determinations of density and solubility are little changed, but Chapter 8, by T. E. McGoury and H. Mark, on the determination of viscosity, is now very much improved by enlargement to twice its previous size. Even yet, it is but twenty-six pages long and attempts to cover far too much in too little space. To-day, the study of high polymers is so important a subject that some mention of 'anomalous viscosity' should certainly have been included.

W. D. Harkins has enlarged by some twenty per cent his two chapters on the determination of surface and interfacial tensions and on the properties of monolayers. In particular, he has, together with G. W. Thompson, included much better discussions of the significance of these measurements. The sixty-page chapter on the determination of osmotic pressure, by R. H. Wagner, is twice its former size and now deals quite comprehensively with this rapidly developing subject. Again, Chapter 12 on diffusivity has been improved by a fifty per cent increase.

Chapter 13, by J. B. Nichols and E. D. Bailey, is a new and valuable account, in 110 pages, of the ultracentrifuge and of the various techniques connected with its use. This fills, at adequate length, one of the major gaps of the first edition. Towards the end of Volume 1, E. E. Jelley's 130-page chapter on microscopy has been rewritten throughout so as to cover several more topics, such as phase-contrast imcroscopy and photomicrography. A short section on the electron microscope has been included, though little scope has yet been found for this instrument in organic chemistry. The chapters on the determination of crystal form and on crystallochemical analysis needed, and receive, no amendments.

I. Fankuchen's chapter on X-ray diffraction now starts Volume 2. It is still only thirty-four pages long and is too much of the form of an elementary essay-review of this highly developed subject. Key references to books which deal adequately with X-ray techniques could have been set out much more prominently in a reference handbook of this character. An ideal treatment of a related topic is to be found in L. O. Brockway's following chapter on electron diffraction, which ends with most valuable comments on "accuracy of results and limitations of the method".

The large chapters on optical measurements (refractometry, by N. Bauer and K. Fajans; spectroscopy and spectrophotometry, by W. West; colorimetry, photometric analysis, fluorimetry and turbidimetry, also by W. West; and polarimetry by W. Heller) constitute about half of the second volume, and are relatively little changed in the new edition, although in Chapter 21 W. West has added useful details concerning light sources for use in spectrophotometry, and in Chapter 22 has added a thirty-page section on nephelometry and its modern analytical applications. While these detailed chapters refer often to the expensive modern automatically recording apparatus, they do not neglect giving detailed accounts of simpler apparatus which is within the means of the average scientific laboratory.

Chapter 24, by C. P. Smyth, on dipole moments, has been enlarged from thirty to forty pages, but is still no more than a good brief summary of this subject and is helpful chiefly for its key references. To the previous chapters which dealt adequately with conductometry, potentiometry, polarography and magnetic-susceptibility measurement has now been added a new Chapter 26 by D. H. Moore on electrophoresis, which fills the major gap among electrical techniques. This chapter describes in detail the design of the Tiselius apparatus and indicates its biochemical applications.

The two concluding chapters have been rewritten, and substantially improved, by additions. Radioactivity measurement is treated by W. F. Bale and J. F. Bonner with the requirements of research chemists in view, and particular attention is paid to estimation of the more important tracer elements such as tritium, carbon-14 and sulphur-35. It indicates the ways in which representative samples can best be collected at the termination of organic and biochemical manipulations and gives a valuable guide to the planning of radiochemical experiments. Similarly, the chapter by D. W. Stewart on mass spectroscopy is now comprehensive in its outlook. It deals well with isotope dilution techniques involving carbon-13 and nitrogen-15, and also outlines the wider applications of mass spectroscopy to gas analysis and to hydrocarbon chemistry generally.

Though expensive to the British purchaser, this second edition of "Physical Methods of Organic Chemistry" is well worth its cost. It is beautifully set out, with abundant clear illustrations of permanent value, and can reliably be taken as the best source of references to the original literature. It certainly will not become obsolete for many years.

W. A. Waters

LINGUISTICS IN ULTIMA THULE

Origin of Language

Four Essays. By Prof. Alexander Jóhannesson. Pp. 172. (Reykjavík: H. F. Leiftur; Oxford: B. H. Blackwell, Ltd., 1949.) 15*s*.

THE gestural or 'ta-ta' theory of the origin of language has a long pedigree, beginning with Plato and achieving its most notable modern exponent in Sir Richard Paget. That Prof. Jóhannesson had been attracted to this theory was evident from his earlier work, "Um Frumtungu Indógermana og Frumheimkynni"; and the dedication of this new volume to Sir Richard sets the author decisively among those who believe themselves capable of demonstrating that language originated in the imitation by the vocal organs of physical shapes and movement. This theory represents one branch of the more general doctrine which sees a natural connexion between things and their names: and it is not to be denied that certain sound-complexes seem, in fact, to be particularly appropriate to the representation of certain shapes—a field of study in which Koehler and the *Gestalt* psychologists have collected some interesting data. But even supposing that these sound-complexes could be shown to involve vocal movements related to the shapes concerned, this would teach us nothing about the origin of language, which must be far remote from the attested or 'reconstructed' forms on which the theory is based—though Prof. Jóhannesson gives one the impression that he believes his hypothetical Indo-European forms at least to approximate to a primitive tongue.

Apart from these general objections, the primary requisite for a study of this theory should surely be a knowledge of the way in which speech-sounds are formed; but the author clearly does not accept present-day views on phonetic matters. To quote a few examples which speak for themselves: Hebrew *g*, *q* and *h* are all classed as "palatals", *r* is a "vibrating cacuminal" and *l* is formed by the "play of the tongue against the soft palate".

The attempts to relate the vocal movements to the physical shapes and actions are, to say the very least, remarkable; words for 'cutting', we are told, are made by curved movements of the tongue "in imitation of a curved movement made by cutting with a primitive instrument such as a scythe"; the Hebrew word for 'ankle' is derived from a verb meaning 'to reach', because it designates "the place to which the overclothing reaches"; and the word for 'foot' is derived from a "slight movement upwards" and so (a magnificent *lucus a non lucendo*) "dangling". Here in 1949 we are back in the linguistic climate of 400 B.C., with the difference that Plato *intended* many of his examples as jokes.

The author's comparative method is not far in advance of his phonetics and semantics, Walde-Pokorny is uncritically cannibalized, and "the IE sound-shift, the so-called Ablaut" is typical of the terminology. The one sound principle stated, namely, to distinguish between radical and affixal forms, is effectively negatived by the lack of any consistent doctrine of root-structure; and the only acceptable conclusion—that many parts of the body are named after their curved or swollen shape—has long been a commonplace of etymology. However, neither these nor any other criticisms are likely to shake Prof. Jóhannesson's sublime but ill-founded confidence that his work "confirms fully the gesture theory of the origin of language" (this in bold type).

Some allowance must, of course, be made for the geographical remoteness of Reykjavík. But it is disturbing that an Oxford professor of philology should have set his name to the preface; this, however, becomes more understandable when we read his remarkable statement that whereas "m is formed by closing the lips . . . many roots describing opening or the like begin with a p *which is made by opening the lips wide*" (my italics).

W. S. ALLEN

A WESTERN CRITIC OF SOVIET BIOLOGY

Death of a Science in Russia

The Fate of Genetics as described in *Pravda* and Elsewhere. Edited by Prof. Conway Zirkle. Pp. xv+319. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1949.) 30*s*. net.

IT is evident from the title of this book that Prof. Zirkle does not approach his subject with an unbiased mind. This is a pity, because it would be very useful to have a properly edited collection of the scientific documents on which Michurinian genetics is founded, with dispassionate and informed commentary from someone familiar with both genetics and the Russian people. Prof. Zirkle's book does not supply this need.

The book is an anthology of statements, most of which are already available to the English reader, about the recent genetics controversy in the U.S.S.R. It has to be judged, therefore, on discrimination in the choice of the statements and on the illumination provided by the editor's comments. The statements Prof. Zirkle has selected range from journalistic articles in *Pravda* and the *Nineteenth Century* to long extracts from the familiar verbatim account of the meetings of the Lenin Academy of Agricultural Science. Documents which it would have been valuable to have in English, such as the paper by Avakyan and Yastreb in *Yarovizatsia*, or the more recent writings of Glushchenko, are not included in the anthology, and in their place are documents by observers with no special knowledge of the situation, some of which are inflammatory without being illuminating.

Prof. Zirkle's own views are contained in the introductions to chapters (for example, the chapter entitled "The Witch Hunt gets Under Way") and in footnotes throughout the book. He treats the biology controversy as though it were an isolated calamity in Soviet history: in fact, it is a detail in a much larger pattern which includes music, the arts, and Soviet law. He says "there are rumours" that the practice of vernalization has ceased; in fact, it has been known for six years that vernalization was never widely practised and that large-scale experimentation with it ceased ten years ago. He states that "in his dotage" and on the strength of his Bolshevik record, Michurin became anti-Mendelian: in fact, Michurin was publishing anti-Mendelian articles in 1910. He labels Michurin an "importer of plants": in fact, Michurin's sole contribution to Russian horticulture was that he broke the old tradition of using imported varieties of fruit trees, by insisting on hybridizing them with selections from local varieties. He asserts that "ever since 1940 . . . genetics had been under a cloud of official displeasure": in fact, reference to the *Doklady Akademi*

Nauk demonstrates that so late as 1945 genetics was flourishing in the U.S.S.R.; and in that year there was a proposal to set up in Moscow a second genetics institute, under Dubinin. In brief, Prof. Zirkle's editorial comments suffer from weaknesses which are very serious in a polemical work on a subject of such international importance.

The Western world has, very properly, been shocked by the restraints upon freedom which have recently been imposed upon Russian men of science. But the best contribution a Western man of science can make to relieve this situation is, surely, to present an objective and unprejudiced analysis of it, not to add to the already swollen stream of political pamphlets.

ERIC ASHBY

WATER ECONOMY OF THE HIGHER PLANTS

Water in the Physiology of Plants

By Prof. A. S. Crafts, Prof. H. B. Currier and Prof. C. R. Stocking. (Plant Science Books, Vol. 21.) Pp. xxii+240. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd., 1949.) 6 dollars.

IT is a familiar fact that water not only plays an all-important part in the physiology of plants, but that it also constitutes a large proportion of their material substance. This being so, the appearance of an authoritative treatise giving particulars of recent investigations concerning the role of water in the physiology of the higher plants is a welcome and important event. The authors state that the book is intended mainly for reference purposes, for which reason they have written it in the form of a critical summary of recent work with the addition of just sufficient narrative to produce a connected whole. The authors hope that the book will be used in the classroom as well as for reference; but, as much of the subject-matter is somewhat involved, it appears to the reviewer that its use for teaching will have to be confined to advanced students.

The authors rightly stress the fact that the part which water plays in the physiology of plants cannot be fully understood without a knowledge of its physical properties and molecular structure. They therefore appropriately start with a discussion of the structure of water, continue with the properties of solutions, osmosis and osmotic pressure, which, in turn, leads on to the role of water in the life of the cell. Finally we come to the uptake and movement of water in plants, and the retention and loss of water by and from plants under different conditions. There is a useful bibliography of recent literature, and authors and subjects are indexed separately. The text is illustrated with numerous graphs and diagrams. In addition, a tribute is paid to the pioneer European physiologists by including pictures of Dutrochet's apparatus "pour mesurer la force de l'endosmose", of Pfeffer's original apparatus for determining osmotic pressure from his "Osmotischen Untersuchungen" and of Hales's experiments on the uptake of water by trees from his "Vegetable Staticks".

In these days when many new technical terms are constantly being coined by specialists in different fields to suit their own respective purposes, it is encouraging to note that the authors stress the importance of evolving a language which is common to physical as well as botanical science. Another excellent feature of the book is the fact that the authors describe the structure of the plants with which they are concerned in sufficient detail to give a clear picture of how structure and physiological behaviour are interrelated. They also call for precision in the use of technical terms. In this connexion a point to which attention might be directed is that the component cells from which a xylem vessel is derived are now generally referred to as 'members' or 'elements', the use of the older term 'segment' as employed in this book having been discontinued after international discussion.

In reading the book under review, one cannot fail to be impressed by the number of topics concerning which differences of opinion have been expressed by various investigators. This is doubtless partly due to differences of interpretation, and faulty or insufficiently critical experimental methods. On the other hand, it should always be remembered that plants tend to become progressively less like each other as evolution proceeds. Although many physiological processes are common to numerous higher plants whatever their taxonomic affinities may be, one would expect the increasing morphological diversity to be accompanied by corresponding physiological divergencies. There is, in fact, no standard physiology that is equally applicable to all plants. That physiological differences must occur is clearly indicated by structural features. Thus, for example, the secretory cavities that occur in the vegetative organs of all members of the Guttiferæ, or the laticiferous elements that are restricted to well-defined taxonomic groups such as the Cichorieæ section of the Compositæ, must clearly be structural expressions of physiological diversity. The recent considerable developments in the use of selective herbicides provide further evidence of the existence of important differences in the physiological make-up of unrelated plants. Since it is clear that such physiological diversities must occur, may it not be that there are variations, still awaiting discovery, in the way in which water itself behaves in plants of different taxonomic affinities. Thus, in considering such a controversial subject as the mechanism by which sap rises, it seems improbable that the forces involved, even if they are of the same type, will operate in precisely the same way in all plants. For example, in a stem with apical growth the youngest tracheal elements are terminal, or nearly so, while, when growth is intercalary, the youngest conducting elements are situated between two sets that are more mature, as in some of the monocotyledons with a creeping rhizome. Surely a structural difference such as this must be accompanied by at least a modification of the mechanism by which sap rises. Owing to the desire to express physiological processes in terms of scientific laws, attention tends to be focused so much on similarities in the metabolism of plants that the differences are apt to be overlooked. To the reviewer, whose own researches have been concerned mainly with correlating histological structure with taxonomic affinity, it seems clear that there is a great and almost unexplored field awaiting the physiologist with the time and inclination to investigate the extent to which differences in physiological behaviour can be correlated with the taxonomic affinities of the plants in which they are exemplified.

Meanwhile, we may welcome "Water in the Physiology of Plants" as a useful summary of what is at present known about this fundamental aspect of plant physiology, and as a valuable addition to botanical literature.

C. R. METCALFE

BOND ENERGIES AND BOND LENGTHS

ON March 9 the Royal Society, with the president, Sir Robert Robinson, in the chair, held a discussion on the subject of bond energies and bond lengths. The meeting was opened by Prof. M. G. Evans, and then followed ten papers on various aspects of the subject, both experimental and theoretical. The greater part of the day's discussion was devoted to the measurement and interpretation of bond dissociation energies and interatomic distances in molecules; but several points of interest also arose in connexion with dipole moments and force constants, which are intimately bound up with bond strengths in a manner not yet fully understood.

In his introductory remarks Prof. Evans suggested a classification of bond properties into those mainly associated with σ-electrons and those mainly associated with π-electrons. The first five contributions to the discussion were concerned principally with σ-bonds, and the last five with σ-π-bonds. The length of a bond is a quantity of unambiguous interpretation, but the concept of bond energy requires some clarification. The thermochemical heat of formation of a compound from the elements in standard states is a measurable quantity, and so is the heat of formation of a molecule or radical from its atoms in specified states; but as a rule the heat of formation cannot be partitioned among the various bonds in any unique manner. For example, the energy to be associated with the O—O bond in hydrogen peroxide is found to be 33 or 52 Cal./mole according as the O—H bond energy is calculated from the heat of formation of water or from that of the hydroxyl radical. Prof. Evans suggested that the dissociation energy of a bond—that is, the energy required to rupture the bond in a given molecule—was a more satisfactory concept because bond dissociation energies are directly measurable and can be expressed entirely in terms of the heats of formation of atoms, molecules and radicals. There is no reason why the dissociation energies of similar bonds in different molecules should be equal; indeed, differences in dissociation energy between bonds of the same kind in different molecules give valuable information about resonance energies and promotion energies in the various molecules or atoms concerned. With regard to promotion energies, Prof. Evans cited the fact that the energies required to remove successive methyl groups from mercury dimethyl are 50 and 8 Cal. respectively; the smallness of the latter figure is almost certainly due to the loss of energy by the resulting mercury atom as it falls from the divalent triplet-state to the normal ground-state. Coming to the more difficult question of the relation between bond strength and the atomic numbers of the atoms concerned, Prof. Evans outlined briefly the theory of ionic-homopolar resonance and described how it had been applied to the mechanical properties of bonds. He felt that, in spite of its comparative successes, the theory needed drastic revision, and said that this question would be dealt with more fully by later speakers. But the concepts of the theory have such a widespread application that it may be possible to re-interpret the theory in new and more fundamental terms.

The next speaker, Dr. M. Szwarc, described the experimental methods which have been used for measuring bond dissociation energies and the heats of formation of radicals. It is possible in principle to measure either the energy of combination of two radicals to form a molecule, or the energy of the reverse reaction. The former method has been applied to the combination of hydrogen atoms and the combination of oxygen atoms, but is not generally a practicable method. However, the unimolecular dissociation of a molecule into two radicals can be conveniently studied by a number of methods, including electron bombardment, photodissociation and thermal decomposition. It can be shown that in cases of interest the activation energy for the thermal decomposition is identical with the dissociation energy of the ruptured bond, so that bond dissociation energies can be determined from the measured activation energies of unimolecular dissociations. The principal kinetic problem is to eliminate the radicals formed in the decomposition, since these may recombine or initiate chain reactions and thus make the overall kinetics of the reaction very difficult to unravel. This problem is solved by using toluene as a carrier gas; it is found that many radicals react instantly with toluene, according to the equation:

$$C_6H_5CH_3 + R\cdot \rightarrow C_6H_5CH_2\cdot + RH,$$

and the resulting benzyl radicals survive long enough to escape from the zone of reaction, eventually forming dibenzyl. Thus the rate of the unimolecular decomposition $R_1R_2 \rightarrow R_1\cdot + R_2\cdot$ can be measured by the rate of formation of either R_1H, R_2H or dibenzyl. This technique has been used for measuring the heats of the following bond dissociations:

(1) $C_6H_5CH_2CH_3 \rightarrow C_6H_5CH_2\cdot + CH_3\cdot$ (77·5 Cal./mole)
(2) $C_6H_5CH_2Br \rightarrow C_6H_5CH_2\cdot + Br\cdot$ (63 ,, ,,)
(3) $C_6H_5CH_3 \rightarrow C_6H_5CH_2\cdot + H$ (50·5 ,, ,,)
(4) $N_2H_4 \rightarrow 2NH_2\cdot$ (60 ,, ,,)

In the first three of these reactions the heats of formation of the species concerned, except the benzyl radical, are all known from other sources. Therefore, the heat of formation of the benzyl radical can be calculated from any one of the three bond dissociation energies, and the concordance of the results provides a valuable cross-check on the measured bond dissociation energies. Dr. Szwarc concluded by describing briefly a modification of the same method, by which it is possible to determine the influence of substituents on bond dissociation energies, for reactions in which the frequency factor has a constant value.

In reply to a question by Sir Robert Robinson, Dr. Szwarc described the precautions which had been taken in analysing the products, so that no important side-reactions should escape detection.

The next paper, entitled "Factors affecting Bond Strengths", was read by Dr. A. D. Walsh, who discussed the concept of electronegativity, its experimental definition and its theoretical significance. Intuitively speaking, electronegativity is a quantity which should decrease on passing down the Periodic Table, and increase with group number within any period of the Table. Pauling's definition of electronegativity, based on thermochemical relationships.

satisfies these requirements, but has little obvious connexion with electrical quantities; whereas Mulliken's definition of electronegativity, as the sum of the ionization potential I and electron-affinity E, is in many cases incapable of experimental utilization. Dr. Walsh suggested that the stretching-force constant of the A—H bond might provide a suitable measure of the electronegativity of element A. Since the electronegativity is also related to the ionization potential, there should be a smooth relationship between $k(A—H)$ and $I(A)$, and indeed the relation $k(A—H) \propto I^3(A)$ is found to hold with fair accuracy for some thirty-five diatomic hydrides. For bonds of the type $A—B$, where neither A nor B is hydrogen, there is a linear dependence of $k(A—B)$ on $I(A)$ as A varies within a vertical group of the Periodic Table; but certain anomalies show that repulsion between lone pairs on A and B must have an important effect on the $A—B$ force constant. In polyatomic molecules the electronegativity of a multivalent atom must be dependent on its state of hybridization; and Dr. Walsh suggested that the small differences in C—H force constant between methane, ethylene and acetylene were due to this effect. Summing up his remarks, Dr. Walsh said that any theory of the factors affecting bond strength must comprehend the striking relationships which are observed between force constants and ionization potentials, and that there seemed to be good experimental grounds for connecting the electronegativity of an element with the force constant of its bond to hydrogen.

Commenting on Dr. Walsh's paper, Dr. J. W. Linnett agreed to the value of any attempt at an improved definition of electronegativity. However, in correlating force constants with ionization potentials, the same difficulty arises as in applying Mulliken's definition of electronegativity, namely, that it is not possible to measure directly the ionization energy of the appropriate valence state; a correction should really be applied to take account of the change in multiplicity accompanying the ionization. Dr. Linnett went on to give an illuminating pictorial sketch of the way in which the valence state of a carbon atom will govern the strength or force constant of a C—H bond.

Dr. H. A. Skinner asked whether the apparent anomalies observed by Dr. Walsh in bonds between atoms having unshared electron pairs are, in fact, real; such atoms would have comparatively large electron affinities, and the electron affinity would play as large a part as the ionization potential in determining the electronegativity, as indicated by Mulliken's definition. The anomalies might be largely due to neglect of these electron-affinity terms.

The next speaker, Dr. E. Warhurst, discussed ionic character in bonds and its relation to bond lengths and other properties. As he pointed out, the theory of ionic-covalent resonance in single bonds involves assumptions which are incapable of proof from first principles and rests largely on the successful interpretation of various experimental results. The phenomena to which the theory has been successfully applied include: ionic resonance energies, as discussed by Pauling in terms of the electronegativity concept; the dipole moments of simple halides and hydrides, studied by Wall, Baughan, Evans, Polanyi and Fairbrother; bond contractions relative to the covalent radius sum (Warhurst); and the dependence of force constants upon the dielectric constant of the environment. However, the assumptions involved in the theory are in many cases open to severe objection; for example, it is necessary to assume that the deviations from charge symmetry in the bond arise entirely from the ionic part of the wave function, whereas contributions to the total bond-moment will, in fact, arise also from the covalent part of the wave function in a heteronuclear molecule. Further, there is considerable uncertainty in the matrix elements occurring in the secular equation and their variation with internuclear distance; and, although simple assumptions about these quantities lead to reasonable agreement with experiment, the theoretical basis of such assumptions is by no means clear. Dr. Warhurst ended with the hope that it would be possible to reformulate the theory of ionic-covalent resonance in such a way that its successes can be more easily understood in terms of fundamental physical principles.

Commenting on Dr. Warhurst's paper, Prof. E. B. Wilson stressed the grave difficulties accompanying the calculation of dipole moments from first principles; the homopolar (covalent) contribution to the dipole moment of a bond is an exceedingly sensitive function of the form of the atomic orbitals and the extent to which they are supposed to overlap. Indeed, it is surprising that any simple theory should give even a semi-quantitative account of observed bond-moments, and discrepancies should not be taken too seriously.

The next contribution was a paper, by T. L. Cottrell and Dr. L. E. Sutton, entitled "Covalency, Electrovalency and Electronegativity". Dr. Sutton described calculations that have been made on a number of idealized molecules, with the view of obtaining a clearer understanding of the dependence of bond strength on nuclear charge in diatomic molecules. The Heitler–London–Sugiura treatment has been extended to electron-pair bonds between nuclei the charges of which are greater or less than that of an electron and may or may not be equal. It is found that transfer of positive charge between initially equal nuclei leads to an increase in the purely covalent part of the binding energy, this effect being largely due to the decreased internuclear repulsion, and independent of any ionic character in the bond. These results make it possible to reconcile Pauling's adjacent charge rule with Gordy's rule connecting electronegativities and bond strength. They also clarify the basis of Pauling's electronegativity scale, and justify Walsh's views concerning polarity and bond strength. As Mr. Cottrell said in the succeeding discussion, "Perhaps the most interesting result of our calculations on model systems is that the covalent energy for heteronuclear molecules is much greater than that given by the geometric or arithmetic mean rule. This means that calculations on covalent-ionic resonance, assuming the geometric mean rule, may not be valid if it is considered that the covalent bond is described by a Heitler–London wave function."

The last paper in the 'mainly sigma' part of the discussion was read by Prof. C. A. Coulson, who gave a critical survey of the method of ionic-homopolar resonance and a statement of the present theoretical position. In order to use the method in a quantitative manner, it is necessary to know the energies to be associated with the covalent and ionic parts of the wave function and the covalent-ionic exchange integral. Three main difficulties of principle appear in the conventional treatment: first, there seems to be no clear justification for the use of a mean rule in calculating the covalent energy term; secondly, it is

uncertain whether the same atomic orbitals are appropriate both for the covalent and ionic parts of the wave function; and thirdly, whatever the best atomic orbitals may be, the bond properties will depend profoundly on the degree of hybridization of these orbitals. Hybridization determines the covalent radius of the atoms forming the bond, the covalent energy term and the charge distribution, especially that part of the dipole moment associated with atomic lone pairs. These difficulties are all repeated in polyatomic molecules, with the added complications of bond delocalization, an interdependence of the ionic character of adjacent bonds, and the possibility of 'bent bonds' being formed in certain cases. The case of water has been worked out in some detail (H. H. Greenwood and U. Danielsson). Working backwards from the observed valence angle and dipole moment, and allowing for a homopolar dipole due to the difference in size between a hydrogen atom and an oxygen, it is found that the individual hydroxyl bonds have dipole moments in the opposite sense from the molecular dipole moment, which arises almost entirely from the unshared electrons of the oxygen, and scarcely at all from any ionic character in the bonds themselves. Prof. Coulson suggested possible lines for future work, including the study of pairing schemes, the theoretical evaluation of covalent bond energies, the relation between hybridization and ionic resonance, the conditions favouring *p*- and *d*-hybridization, and a study of the repulsions between valence-shell and inner electrons, which often play an important part in determining bond lengths and force constants.

The second part of the discussion, on σ-π-bonds, was opened by Sir John Lennard-Jones. He traced the concept of the π-bond from the early days when it was introduced to account for the paramagnetism of the oxygen molecule and the torsional rigidity of the ethylene molecule, and reviewed briefly its application to unsaturated organic molecules. Within the framework of molecular orbital theory, the idea of delocalized π-electrons has been very fruitful; it has been possible to make extensive calculations of resonance energies and bond lengths, assuming that the so-called 'resonance integral' between adjacent atomic orbitals is a simple function of the distance between the atoms concerned. The strict calculation of bond lengths in unsaturated molecules involves the technique of successive approximations, since there is a cyclic dependence between energy, resonance integrals and bond lengths. However, Coulson's definition of bond order provides a very convenient technique for the calculation of equilibrium bond lengths, since to a good approximation there should be a smooth relation between bond order, as usually calculated, and bond length; and Coulson's bond-order/bond-length curve has been successfully used for predicting carbon – carbon bond lengths in many unsaturated hydrocarbon molecules. More recently the theory has been developed to deal with the chemical reactions of conjugated molecules, with promising results. In hydrocarbon ions such as the benzyl cation or anion, the electron defect or excess can be shown to be associated with alternate atoms in the system, in agreement with the qualitative resonance theory; and such results point the way to a simple semi-quantitative molecular orbital theory of organic reactivity. The implications of these ideas were still being worked out, and would be discussed in the last paper of the afternoon. In conclusion, Sir John expressed the view that we now had an inherently sound theory of the various factors affecting bond lengths in conjugated hydrocarbons and reactivities in simple heteromolecules; but, as would emerge from the next few papers, there were still a few discrepancies which had not yet been resolved, and it remained to be seen how far the theory of bond lengths would be capable of extension to molecules other than aromatic hydrocarbons. In such molecules molecular orbital theory is no longer strictly self-consistent and may require modification in order to overcome this difficulty.

Prof. J. M. Robertson then read a paper on the X-ray measurement of bond lengths in planar aromatic hydrocarbons. Such hydrocarbons may be classified according to their crystal structures into two fairly distinct types. The first class includes pyrene $C_{16}H_{10}$, dibenzanthracene $C_{22}H_{14}$, coronene $C_{24}H_{12}$ and ovalene $C_{32}H_{14}$. These molecules tend to stack in columns, the molecules in each column lying at about 45° to the symmetry plane of the crystal; and their structures may be obtained with considerable accuracy by calculating electron-density projections on the symmetry plane. In Prof. Robertson's opinion, the measured bond lengths for pyrene are probably accurate to about 0·03 A., the observed variations being from 1·39 to 1·45 A. Comparison of the experimental lengths with those calculated by Coulson gives an average discrepancy of 0·022 A., which is less than the estimated experimental error. For coronene and ovalene the resolution is better, and the estimated experimental error is only 0·01–0·02 A. In both these cases the average discrepancy between theory and experiment is 0·013 A., which is quite as satisfactory as can be expected. The second class of molecule studied includes naphthalene and anthracene, in which the molecules are more steeply inclined to the symmetry plane of the crystal. Here it is necessary to make a comprehensive three-dimensional analysis, which gives values for the bond lengths correct to 0·01 A. or better. There are some discrepancies with theory which appear simply to involve an error of scale, but apart from these the central bond in naphthalene does appear to be appreciably longer than theoretical calculations suggest. Nevertheless, Prof. Robertson felt that, on the whole, the agreement between theory and experiment was extremely satisfactory and amply justified the large amount of work which had been expended on these structures.

The next contribution to the discussion was from Prof. E. G. Cox and Dr. G. A. Jeffrey, who discussed bond-order/bond-length relationships in conjugated heteronuclear molecules. The theoretical calculation of bond lengths in such molecules requires the knowledge of certain energy parameters the values of which would determine the bond orders; the bond length would then presumably be a smooth function of bond order, as in the unsaturated hydrocarbons. A most important step, therefore, in the theoretical interpretation of bond lengths is the construction of reliable bond-order/bond-length curves for as many atom pairs as possible. The minimum requirements for such a curve are (1) the length of a pure single bond, (2) the length of a pure double bond, and (3) the length and order of some intermediate bond. Prof. Cox considered in turn carbon–nitrogen, carbon–sulphur and carbon–oxygen bonds, for which most experimental data are available. The C—N single-bond length is known to be $1{\cdot}47_5$ A., and 1·27 A. is a plausible length for the C=N double bond. Pyrrole and pyridine provide intermediate points; and,

although they are not consistent, suggesting that the electron-diffraction data on pyrrole are unreliable, the general trend of the curve is reasonably certain. It is interesting that the carbon–nitrogen bond length is not as sensitive to hybridization as might have been expected, and also that a surprisingly large number of carbon–nitrogen bonds lie in a narrow range corresponding to bond orders of 1·5–1·8. Prof. Cox suggested that cyclic molecules such as melamine might well repay further theoretical study. Bonds between carbon and sulphur have been less completely studied. The single-bond length is 1·81 A. but the double-bond length is much less certain (? 1·63 A.). The only satisfactory intermediate point is derived from recent experimental and theoretical studies on thiophthen (Cox, Gillot and Jeffrey; Evans and de Heer; and Longuet-Higgins). The excellent agreement between theory and experiment for the carbon–carbon bonds in this molecule suggests that for the carbon–sulphur bonds the calculated orders and observed lengths probably provide the most reliable intermediate points available. The situation with regard to carbon–oxygen bonds is unsatisfactory, and urgently demands both experimental and theoretical attention. Dr. Jeffrey mentioned barbituric acid and diketopiperazine as worthy candidates for theoretical study in the future.

A general survey of bond length calculations in conjugated molecules was then given by Prof. Coulson. As he explained, in molecules containing σ–π-bonds it is always assumed that the σ- and π-electrons may be treated separately. The σ-electrons are supposed to be localized, and the energy and wave function of the π-electrons are then obtained either by the valence bond method or by the method of molecular orbitals, in terms of exchange or resonance integrals. Except for simple molecules, it is not practicable to calculate the equilibrium lengths by minimizing the energy with respect to variations in bond length, and one has to fall back on the concept of fractional bond order, which should be smoothly related to bond length. Robertson's accurate work on naphthalene and anthracene shows that this idea is sound, but there are small discrepancies which may be removed by further refinements in the theory. Such refinements present certain difficulties: for example, it is not known to what extent hybridization will affect bond lengths, and in heteromolecules a self-consistent field approach may be necessary; but certain improvements can undoubtedly be made in bond-length calculations. These improvements include: making allowance for bond-length changes due to repulsion between neighbouring net charges and to mutual polarization of the atoms; allowing for variations in resonance integral due to inequalities of bond length, and obtaining a consistent set of such integrals by iteration; and investigating the effects of interaction between different electronic configurations. All these improvements have been applied to naphthalene and have corrected the simple calculations by about 0·005 A. each. It would therefore be impossible at present, without very detailed study, to predict lengths to better than about 0·015 A. in hydrocarbons or 0·03 A. in other kinds of molecule.

The last paper in the discussion, read by Dr. H. C. Longuet-Higgins, was entitled "The Influence of Conjugation on Ionic Dissociation Energies". Dr. Longuet-Higgins considered the ionization of hetero-aromatic amines of the type of the amino-quinolines. By a combination of molecular orbital theory and first-order perturbation theory, it can be shown that the ionization energy of such an amine is linearly related to the π-electron density at the appropriate position in the iso-electronic hydrocarbon. For amines of the type under consideration, the iso-electronic hydrocarbon would be a carbanion, with π-electron densities equal to $1 + c_r^2$, where c_1, c_2, etc., are the atomic orbital coefficients in a non-bonding molecular orbital. The values of these coefficients can be written down by inspection, and so it is possible to find the required electron densities in a very simple manner. It is found that the charge excess in the carbanions is invariably distributed over alternate atoms only, so that the π-electron densities would be alternately greater than and equal to unity throughout the molecule. Although no direct experimental data are available on heats of ionization, an approximately linear relation is found to hold between the calculated electron densities and the measured free energy of ionization (Albert, Goldacre and Phillips) for forty-one amines belonging to thirteen different heteroaromatic systems. Among the available data a few anomalies are observed, but these are without exception molecules in which the amino group is ortho or peri with respect to the nuclear nitrogen atom. The agreement between theory and experiment is surprisingly good, considering the drastic assumptions of the theory and the fact that solvent and entropy effects are not allowed for. This agreement seems to substantiate the view that the π-electron system plays a predominant part in determining the tendency of such bases to accept a proton; and there is hope that similar elementary calculations will be successful also in other fields of physical organic chemistry.

Summing up the day's discussion, Prof. Evans said he felt that it had succeeded in bringing together many important lines of research into bond properties and their theoretical interpretation. The work of Szwarc and others showed more clearly than ever the importance of radical resonance energies and the valence-state energies of atoms in determining bond dissociation energies. The calculations of Cottrell and Sutton, and the empirical rules enunciated by Walsh, made it clear that the concept of electronegativity is still a fruitful one, although its precise significance is still open to discussion. Warhurst's work showed that the same is true of the theory of ionic-covalent resonance, although, as pointed out by Coulson, orbital hybridization might invalidate the approximations of the theory, especially as applied to dipole moment calculations. On the subject of bond lengths, Prof. Evans agreed with Sir John Lennard-Jones that we now seemed to have an essentially sound theory of the lengths of σ–π-bonds, at any rate in aromatic hydrocarbons. It was gratifying that Coulson's refined calculations on naphthalene justified so happily the neglect of configurational interaction in the more naïve theory of bond order and bond length; very few people would complain of an inaccuracy of as little as 0·015 A. in *a priori* bond-length calculations. As Prof. Coulson had explained, there might be particular difficulties associated with the calculation of bond lengths in molecules containing heteroatoms; but the success which had attended recent studies on thiophthen seems to justify an attitude of cautious optimism. It seemed that we were gradually obtaining a quantitative theory of the chemistry of hetero-molecules, and might hope to achieve also before long a better understanding of their physical properties.

H. C. Longuet-Higgins

HETEROGENEOUS CATALYSIS

FARADAY SOCIETY DISCUSSION

THE Faraday Society discussion on heterogeneous catalysis, held at the University of Liverpool during April 12–14, was the most international of the post-war discussions of that Society, with papers from Australia, Austria, Belgium, Canada, France, Germany, Greece, Holland, Poland and the United States, as well as Great Britain, and representatives from most of these countries, and from Egypt, Palestine and Sweden.

The discussion ranged over all important work on the subject, and left one with two definite impressions. The first was of the quality and amount of fundamental research carried out in this field by workers in industrial laboratories. Heterogeneous catalysis is obviously of the greatest technical importance, but it is surprising to note that no less than ten of the thirty-six papers presented were by industrial chemists. Moreover, these were not concerned with technical problems, and all made important contributions to the fundamental aspects of the subject. This was particularly true of the impressive work from Imperial Chemical Industries, Ltd., of Billingham, and the Shell Development Co., California. The concern of industry with the fundamental principles of catalysis is of fairly recent growth—at the 1932 Faraday Society discussion on catalysis, for example, only 9 per cent of the work came from industrial sources, compared with 28 per cent at the 1950 discussion—and it is unlikely that we have yet seen the peak of industrial effort in catalysis. The second impression was of the weight of the American contribution. In each of the four sections into which the discussion was divided, American papers were to be found, and, in all, fourteen were presented by them, compared with thirteen papers by British authors.

Prof. H. S. Taylor, of Princeton, opened the conference by giving the first post-war Spiers Memorial Lecture. He set himself the task of resolving the differences in adsorptive and catalytic properties between powdered metals on one hand, and metal wires and evaporated metal films on the other. These differences are considerable. For example, there is evidence that surfaces of powders are heterogeneous, with different surface atoms having markedly different adsorptive powers, and catalytic power possibly confined to a relatively few surface atoms. Also, adsorption by chemical rather than physical force on films and wires is nearly always like certain atomic and free radical reactions, which are non-activated and unlike most chemical reactions which require an appreciable activation energy. Chemisorption by powders, on the other hand, often appears to be slow except at high temperatures, and hence to be activated. Prof. Taylor suggested that these differences in behaviour are due to differences in purity of the adsorbing surfaces, and that even very small amounts of impurity could affect the adsorptive and catalytic power of the whole surface. The surfaces of powders are nearly always initially impure, for it is almost impossible to free them from stable adsorbed contamination. The surfaces of wires cleaned by flashing, and of films generated in a clean state by evaporation in a vacuum or in the presence of a non-adsorbed gas, on the other hand, are initially pure. However, he pointed out that powders must be studied on account of their greater practical importance, and his closing statement was that future interest in catalysis might be more fruitfully directed towards the question of catalyst structure and properties than towards the details of reactions proceeding at their surfaces.

The discussion proper had been divided into four roughly equal sections, headed: theories of adsorption and surface layers, adsorption and catalysis on metals, adsorption and catalysis on oxides, and experimental techniques.

In the theoretical section, two approaches to catalytic problems were made. The first, that of Dr. G. Wyllie and of Prof. C. A. Coulson, considered the approach of an atom to a surface and its adsorption thereon in detail. The second, that of Profs. H. Eyring and K. J. Laidler, calculated the absolute rate of reaction in an adsorbed layer from the point of view of the transition state theory. The paper by Prof. Laidler was probably the most interesting to experimental chemists. In it he calculated the rate of a catalytic reaction between molecules A and B, A being the more strongly adsorbed, for the three general mechanisms: (1) reaction between adsorbed A and adsorbed B, (2) reaction between adsorbed A and gaseous B, (3) reaction between adsorbed B and gaseous A. He obtained criteria for distinguishing between the mechanisms from experimental data, and applied the results to the much disputed question of the mechanism of catalytic hydrogenation of ethylene to show that reaction between adsorbed ethylene and adsorbed hydrogen would be expected.

Most of the theoretical work, however, is not directly concerned with the available experimental data, and is not immediately applicable to experimental results. Chemists still have problems requiring theoretical treatment. Some of these are the occurrence and extent of surface heterogeneity, and of short-range repulsions between atoms adsorbed on adjacent sites, and the conditions under which chemisorbed atoms are translated in the surface layer. These were not treated. The significance of heterogeneity has been mentioned: the magnitude of lateral repulsions gives indirect information on heterogeneity and is a factor in deciding mobility, the occurrence of which may decide the ease of approach of adsorbed atoms, and hence the rate of catalytic reaction.

A large part of the section dealing with catalysis by metals was devoted to the question of catalytic specificity. It has for some time been recognized that there is a geometrical factor in catalysis, and that the ease of fit of reactants to the surface atoms may be of prime importance in deciding the rate of catalytic reaction. Many facts of catalytic specificity cannot, however, be explained by surface geometry alone. Among these are the differences in activity between metals, semi-conductors and insulators. It has recently been suggested that there is an electronic factor in catalysis, with the availability of surface levels for bonding of reactants playing a part in deciding activity. This was first shown to be true by Schwab, when he related the variation of the activity of certain alloy catalysts among which surface geometry scarcely alters, to an electronic effect—the degree of completeness of the first Brillouin zone of the metal. Since then, the idea has been developed that with metals the d-band might be involved in chemisorption, and hence that d-band character would be of great importance in deciding activity of metals and alloys. At the recent discussion, D. A. Dowden and Dr. P. W. Reynolds, and A. Couper and Dr. D. D. Eley, with whom the theory

is to be associated, presented results for certain alloy systems to prove the correctness of their theory. In addition, Dr. O. Beeck, who has previously shown that the activity of pure transition metals towards ethylene hydrogenation is decided by surface geometry, reconciled this result with the newer electron band theories by quoting Pauling's conclusion that the lattice spacing of transition metals is decided by their *d*-band character. He also showed that the heat of chemisorption of hydrogen and ethylene on these surfaces is decided by the metal *d*-band character. The clear statement of the relation of chemisorption and catalytic activity to substrate electronic constitution was the most important achievement of the discussion.

Other papers in the metals section included a simple method of surface-area determination by Dr. E. B. Maxted, K. L. Moon and E. Overgage, based on the sensitivity of the catalyst to poisoning; some elegant work by Dr. J. C. P. Mignolet, which shows that chemisorption may be distinguished from second-layer formation by measurement of the surface dipole produced on adsorption, the two layers often producing opposing dipoles; and a study of hydrogen chemisorption by tungsten by Prof. E. K. Rideal and B. M. W. Trapnell, who find it to be reversible in densely packed layers even at liquid-air temperatures, and suggested that the mechanism of the catalytic parahydrogen conversion is $2W + H_2 \rightleftharpoons 2WH$.

The section on oxide catalysts fell into fairly well-defined categories. First, a group of American papers on insulator catalysts was presented. Examples are silica–alumina and aluminium chloride, and these are active in the cracking of organic molecules, dehydration, isomerization and polymerization. The mechanisms are very similar to those operating homogeneously with strong acids, suggesting that the sites responsible for catalysis are acidic. This is confirmed by the result that the amount of water—a source of protons—at the surface controls the activity. Organic carbonium ions and oxonium ions are thought to be intermediates in cracking, an exchange of protons taking place between adsorbed molecules and the surface. Thus, T. H. Milliken, jun., Dr. G. A. Mills and Dr. A. G. Oblad found that catalyst activity is proportional to the number of surface acid groups. D. R. May, K. W. Saunders, E. L. Kropa and J. K. Dixon find that the cracking-rate of a series of hydrocarbons decreases as the hydrocarbon electronegativity increases. The order is the same as in Hammett's reactivity series, which supports a carbonium ion mechanism. Dr. M. W. Tamele ascribed the formation of surface acidity to the production of electrostatically held protons, and again found a direct proportionality between activity and surface acidity.

The second group of papers on oxides was concerned with semiconductor oxide catalysts, and here the problems discussed were the nature of chemisorption and reaction processes at these surfaces, and properties of the substrate such as the mobility of oxygen in the surface layers. Among the contributions concerned with surface reactions, D. J. M. Bevan and Dr. J. S. Anderson have measured the change in semi-conductivity to investigate the surface equilibrium of oxygen with zinc oxide according to the equation $O^{2-} \rightleftharpoons \frac{1}{2}O_2 + 2\varepsilon$. Prof. W. E. Garner, F. S. Stone and T. J. Gray have combined semi-conductivity and heat of adsorption determinations to obtain information about the reactions of carbon monoxide, oxygen and carbon dioxide at the surface of the cuprous oxide/cupric oxide system. Oxygen was found to be adsorbed on cuprous oxide according to the equations

$$O_2 \overset{1}{\rightleftharpoons} \underset{|\quad|}{O—O} \overset{2}{\rightleftharpoons} 2O \overset{3}{\rightleftharpoons} 2O^-,$$

with 2 or 3 rate-determining. Carbon monoxide is held reversibly either as a CO_2 or CO_3 complex, although CO^+ is a possibility. The reaction $2CO + O_2 \rightarrow 2CO_2$ was formulated by the steps

$$2O^- + CO \rightarrow CO_3^{2-}$$
$$CO_3^{2-} + CO \rightarrow 2CO_2.$$

Among papers concerned with the properties of the catalyst itself, Prof. G. F. Hüttig found that in the interaction between mixtures of oxides, a flow of more mobile oxide over the surface of the less mobile oxide takes place. Dr. E. R. S. Winter described his work on the exchange of oxygen-18 with the oxygen atoms of various oxides using a mass spectrometer, showing that the surface layers of oxide undergo exchange at catalytic temperatures, so that the oxygen ions in the surface are mobile under these conditions. Thirdly, Prof. P. W. Selwood and Miss Lorraine Lyon indicated that measurement of the magnetic susceptibility of catalytically active oxides supported on inert oxides can give much information on the chemical state of the catalyst on the support. One interesting result is that if the radii of catalyst and support cations do not differ by more than about 30 per cent, the catalyst cation can change from its normal valency state to that of the support cation.

The precise measurement of any physical property of gases in the adsorbed state is of the greatest value in elucidating adsorption and catalytic phenomena, and the last section of the discussion was devoted to some of these techniques. Here, Dr. J. A. Morrison and Dr. J. M. Los described a calorimeter enabling heat changes to be measured sufficiently accurately to obtain the specific heats of adsorbed gases; Dr. J. C. P. Mignolet described the best method yet developed for measuring the surface dipole produced by adsorption of gases on solid metals; and the use of isotopes, of semi-conductivity, of small-angle X-ray scattering and of electron microscopy were also discussed. But the two most interesting contributions were from Dr. O. Beeck, W. A. Cole and Dr. A. Wheeler on the determination of heats of adsorption on clean evaporated metal films, and from Prof. P. W. Selwood and F. K. Schroyer on the determination of catalyst accessibility by measurement of proton relaxation-time.

Now measurement of heats of adsorption of the same gas on powders of the same metal by different workers has, owing to the presence of variable amounts of the inevitable surface contamination from which powders cannot be freed, given widely different results. Only wire and film surfaces, available in an adequately clean state, can give reproducible results. But not even all metal wires can be cleaned by flashing, and only the film surface is of general use. Dr. Beeck and his collaborators have developed a method for measuring heats on films so successfully that the accuracy is about 1,000 cal.—a remarkable achievement. Prof. Selwood and Mr. Schroyer measured the fraction of the total catalyst atoms dispersed on a support which is active, and have

shown that the catalyst atoms aggregate into small thick islands instead of spreading uniformly over the support. The correlation of this result with activity measurements has given information on the mechanism of benzene hydrogenation.

In conclusion, the feeling of those present was that while the large number of papers presented left rather too short a time for adequate discussion, as representing work going on in the field of heterogeneous catalysis everywhere except behind the 'Iron Curtain', it was a remarkably complete discussion.

E. K. RIDEAL
B. M. W. TRAPNELL

THE OLDER STONE AGES

RECENT TRENDS AND DISCOVERIES

THE Prehistoric Society held a very successful conference on "The Older Stone Ages: Recent Trends and Discoveries" at the Institute of Archæology of the University of London during April 14–16. The conference was under the able chairmanship of Prof. C. F. C. Hawkes, and the smooth running of the proceedings and efficiency of the administration were in no little way due to the efforts of the London secretary of the Society, Mr. J. W. Brailsford. The subjects dealt with were principally centred on palæolithic problems. Prof. V. G. Childe opened the sessions with an address on the twin approach to the study of prehistory, namely, the scientific and the humanistic. This matter has been much to the fore recently as a result of Dr. Glyn Daniel's new book, "A Hundred Years of Archæology". There are, of course, dangers in both approaches: the humanist is often too prone to project modern conceptions and outlooks into the dim past and to suggest that prehistoric man must have felt and reacted in the same way as does modern man; the geologist, on the other hand, is inclined to forget that he is dealing with the story of man and not of some organic automaton. Because man reacted to some phenomena in a certain way in one place, it does not follow that he will do so in exactly the same way in another. Prof. Childe argued for the dual approach at one and the same time; and, while this may be said to be a platitude, it is an important one and one that must be kept in mind if useful and accurate studies of prehistoric man are to be made in the future.

Dr. Therkel Matthiassen, of the National Museum, Copenhagen, followed with a paper on "Recent Discoveries relating to the Hunter–Fisher Cultures in Denmark". As a result of the shortage of coal during the Second World War, especially extensive peat excavations were undertaken, and much important archæological evidence accumulated. The oldest site unearthed so far in Denmark was at Bromme, where deposits of the Allerød period yielded a rich industry, mostly of flint, but with some antler tools as well. The Allerød stage occurs between an upper and a lower Dryas level and represents a slightly warmer phase than either of these. The culture flourished then, during that dim period between the end of the true palæolithic (Magdalenian) and the earliest Mesolithic proper (Maglemose). It can be considered as a palæolithic survival, as do the Danes, or as the earliest appearance of mesolithic man. As one culture seems to be largely a product of the other, there is little significance in the choice of title.

A large number of true Maglemose sites have come to light, as well as others belonging to the allied Gudenaa culture of Jutland. Finally, recent work on the later culture of the Kitchen Middens has shown that this can be divided into four stages of different ages. As the coast-lines were varying during this period, some of the sites have been found at places to-day far inland which, at the time of their occupation, were actually by the sea. After this able summary by Dr. Matthiassen of the important archæological work which has been done in Denmark in recent years, there followed two films illustrating Eskimo life and crafts in Northern Canada. It was interesting to see how a number of Eskimo objects are made and food secured, but it was obvious that the influence of the white man has been considerable; indeed, Dr. Matthiassen said afterwards that immense modernizing changes had clearly taken place since he studied the folk thirty years ago.

On the morning of April 15 Dr. Charles McBurney opened the proceedings with a paper, illustrated with slides, on the "Geographical Aspects of the Older Palæolithic Cultures", and this was followed by a discussion started by Mr. Miles Burkitt and Dr. Kenneth Oakley. In a sense, Dr. McBurney's thesis confirmed some of the points made by Prof. Childe. It is no longer possible to postulate a uniform spread of similar industries over Europe during early and middle palæolithic times. Especially east of the Rhine—which Dr. McBurney still considers to be the frontier between the *coups de poing* makers of Acheulean facies and the essentially flake-tool makers of central Europe—the number of differing, if allied, industries is considerable. In the course of the paper several of these were reviewed; the discussion spread over a wide field, and a number of useful points were brought forward. The conference was delighted that the veteran prehistorian, Mr. Hazzledine Warren, was present and took part. Mr. Warren was an original member of the Prehistoric Society of East Anglia.

Two important palæontological papers were read in the afternoon: "Pleistocene Elephants and their Stratigraphical Significance", by Prof. R. Vaufrey, of the Institute of Human Palæontology, Paris, and "The Reindeer and the Giant Irish Deer in Ireland", by Dr. Frank Mitchell. Prof. Vaufrey was at pains to show that a considerable overlap exists among the Pleistocene elephants. They cannot be used as type fossils in a steadily evolving stratigraphical sequence. Dr. Mitchell illustrated the distribution in Ireland of the finds of giant deer and pointed out how this coincided with those of the grasslands, scarcely any occurring on what were at the time heathlands. At the same period in England, where forests abounded, the elk—a bark eater—replaced the giant deer.

Later in the day, Mr. Burkitt gave an illustrated talk on the painted cave of Lascaux. He queried whether the thesis could not be sustained that the late Aurignacian artists at Lascaux, while capable of giving the impression of vigour and movement, were unable to depict portraits of special animals, but merely examples of the particular species without any individual character; whereas the Magdalenian artists at Altamira, though their painted animals are all curiously static, do portray individual beasts, each with its own personal character. Miss D. Bate's identification of one of the figures of Lascaux as a Pantholops—a Tibetan antelope or Chiru—was also put forward for consideration of the conference. Mrs. Hawkes opened a very interesting discussion.

There is much still to be done from the humanistic point of view on the late palæolithic art of south-western France and northern Spain. Even if the twin cycles of art are accepted—the one Aurignacian and the other Magdalenian—the problem of the conventions used in making the engravings and paintings remains for an artist to work out. If it should become possible in some cases actually to identify the hand of an individual artist, then perhaps the relative ages of some of the paintings may have to be reconsidered.

A visit was paid to the British Museum (Natural History) on the morning of April 16. Besides viewing the special exhibitions, two papers were read, one by Dr. Oakley on the "Fluorine Dating of Piltdown and other Skulls", and the other by Prof. F. E. Zeuner on "The Radio-Carbon Method of Dating". The fluorine method of dating bones is now well enough known to need no recapitulation here, but Dr. Oakley's application of it to the Piltdown skull is of the highest importance (see *Nature*, March 11, p. 379). Heretofore this skull has been considered to be the oldest fossil remains of man and to date perhaps to the first interglacial period. It can now be shown to be comparatively late in age and to belong to the last interglacial—to be, in fact, only some thirty thousand years or so old. Of course, the problem of the association of the skull with the very peculiar jaw remains to be solved; but this is not entirely a matter of dating.

The radiocarbon method of dating is new and depends on the fact that there is a small amount of radioactive carbon-14 always present in the carbon dioxide of the earth's atmosphere. This carbon-14 decays radioactively with a half-life period of about 5,700 years, but it is being continuously renewed, possibly by the action of cosmic rays on the atmospheric nitrogen. The carbon-14 is assimilated by plants (and by animals through the medium of the plants), but this assimilation ceases when the plant or animal dies. Thereafter the concentration of the carbon-14 in the dead tissue diminishes at the half-life decay rate of 5,700 years, and, by determining the amount of this carbon, it might seem reasonable to determine the age of a given specimen of peat or other organic matter (bones react badly to the method). Prof. Zeuner, though he is optimistic of the possibilities of this method, warned the conference of the difficulties and still unknown factors to be discounted before any certain results can be accepted. However, the ages so far determined with materials of known dates are encouraging, as the method at any rate is correct for the relative dating and apparently reasonably correct for the absolute dating.

At the final session there was a long discussion by a number of speakers on the origin of the Upper Palæolithic in Europe. This was really an extension of Dr. McBurney's earlier paper and followed similar lines. The question as to the Late Palæolithic in North Africa and its relationship with the early Aurignacian cultures of western Europe was raised. Prof. Vaufrey stressed that an essential difference in the industries was the presence throughout the levels in North Africa of pigmy tools. However, it was pointed out that perhaps pigmy tools in an industry merely indicate that composite tools were being made—that is, tools where the 'business' portions were made of flint and the haft of some other material, and that the most usual materials would be soft woods. These would not have occurred in western Europe in any quantity in early Aurignacian times but might well have been plentiful in the latitudes of North Africa. Mr. Leslie Armstrong urged that the late *coups de poing* makers were the first to invent the blade technique.

The conference concluded with a paper by Dr. Grahame Clark and Prof. Stuart Piggott on "The Early Foundations of Neolithic Culture in N.W. Europe". Although the conference was mainly concerned with palæolithic problems, the story of man is a continuum, and the mesolithic and neolithic cultures grew from the older stems. The gulf is still fixed between the earlier food-gatherers and the later food-producers; however, at the same time, intensive study shows that in western Europe it was not a catastrophic change resulting from invasions of new ethnic stocks which wiped out the earlier inhabitants, but rather the incoming of new ideas, possibly only later followed by any large-scale immigration of new folk. This does not necessarily mean that the mesolithic people discovered the possibility of agriculture and the domestication of animals in western Europe itself, but once again, when dealing with humanity, we have to allow for overlaps and gradual rather than catastrophic changes. M. C. Burkitt

OBITUARIES

Prof. G. W. Robinson, C.B.E., F.R.S.

Gilbert Wooding Robinson, who died suddenly on May 6, was widely known as a leading expert on soils. He was born on November 7, 1888, at Wellington, Shropshire, and was educated at several Wolverhampton schools, including the Grammar School: his father had been secretary of the Wolverhampton Education Committee. In 1907 he gained an entrance scholarship to Gonville and Caius College, Cambridge, and entered in October of that year; in 1909 he obtained a first class in Part I of the Natural Science Tripos and passed the examinations in agriculture in 1909 and 1910. In 1911 he was appointed demonstrator in the School of Agriculture at Cambridge, and in 1912 proceeded to the University College of North Wales, Bangor, as adviser in agricultural chemistry, a new post created by the then Board of Agriculture. The Department he built up was so successful that it was given university recognition in 1921, and he was made independent lecturer; in 1926 he was raised to a professorship, and during 1947–48 he served as vice-principal.

At Cambridge Robinson had become interested in the soil surveys then being made under T. B. Wood's direction in Norfolk and elsewhere, and he carried out a survey of the soils of Shropshire. At Bangor he began surveying the soils of North Wales, and was soon confronted with the need for quicker and less cumbersome methods of procedure than those then in general use: these he proceeded to devise. His rapid and elegant method of mechanical analysis was soon universally adopted in Great Britain; he described it in the *Journal of Agricultural Science* in 1922, and discussed the curves expressing the rates of sedimentation of the various soil particles in a second paper in the same *Journal* in 1924. He also shortened the chemical analytical methods and, with his colleague, Rees Williams, developed the acetic acid extraction method. He made extensive studies of the clay fraction of the soil, particularly its base exchange properties and their bearings on soil

analysis and the development of the soil profile; some of the results appeared in the *Journal of Agricultural Science* of 1930.

Meanwhile, other county soil surveys were being made in Britain by local officials working independently of each other without central co-ordination. The surveyors recognized the disadvantages, and established a Soils Correlation Committee, appointing Robinson as chairman. His wide reading and travel had familiarized him with the new ideas and methods developing in the United States, Europe, Russia and elsewhere, and his attractive persuasiveness enabled him to secure a uniform technique of mapping and nomenclature based on the soil profile; he introduced the 'suite' concept in soil classification and used it in Wales for designating his related soils as geologically genetic groups: these ideas and methods are now permanently embodied in soil-survey practice. Various papers on these subjects were elaborated and grew into his most important publication, "Soils, their Origin, Constitution and Classification" (Murby, 1938), now in its third edition (see *Nature*, June 3, p. 866); the University of Cambridge had already in 1936 awarded him the Sc.D. degree for the work.

In 1939 the war conditions necessitated much government action in stimulating food production, and the disadvantages of independent surveys became manifest: it was, for example, impossible to construct a soil acidity map for Great Britain, although thousands of determinations had been made, but the various methods had not been comparable. The whole of the soil survey work was therefore brought under one control, and Robinson was the obvious choice for the directorship, holding this post, along with his professorship, until 1946, when the survey was transferred to Rothamsted Experimental Station. During this war period he was also adviser in agricultural chemistry to the North Wales province.

Robinson's work on soils, however, by no means claimed his whole attention. His breadth of culture was remarkable. In his early Bangor days he became friendly with one of the lecturers on the Classics, and proceeded to study them with such good effect that in 1928 he was elected president of the North Wales branch of the Classical Association, the only agricultural expert for generations who could have achieved such distinction. He had a great flair for modern languages, and could talk Welsh on the Welsh hills and some five or six other languages at international conferences, where his attractive personality made him always a most welcome visitor. In addition, he was a justice of the peace for Caernarvonshire, a member of the Central Advisory Council for Education in Wales (having already served on the Departmental Commission on Rural Education in Wales during 1928–30) and chairman of the Bangor Diocesan Religious Education Committee.

Robinson was twice married: first in 1913 to Winifred, daughter of Mr. J. Rushforth, who died in 1945; and secondly, in 1949, to Mary Isabel, eldest daughter of the late Dr. H. L. James, Dean of Bangor. By the first marriage there was one son, now in Johannesburg, and three daughters.

He led an extraordinarily full and varied life, yet never seemed hurried or tired; he was a very acceptable member of any circle, whether a university senate, a social gathering or a golf club. Few men in the profession of agricultural science have been more trusted by their colleagues or held in more affectionate esteem than he was.

E. JOHN RUSSELL

Dr. Herman Shaw

DR. HERMAN SHAW, director of the Science Museum, London, died suddenly at his home in Barnes on May 4. Born on October 14, 1891, he was educated at Bradford Grammar School, where he was a Governors' Scholar, and the Imperial College of Science and Technology, London, where he held a Royal Scholarship and, later, an Aeronautics Research Scholarship. During the First World War he served as a lieutenant in the R.N.V.R., a flight lieutenant in the R.N.A.S. and a captain in the R.A.F.

Shaw entered the Science Museum in 1920, and at once began to display evidence of his characteristic ability and energy. The Museum had acquired from Budapest in 1920 an example of an Eötvös torsion balance, and in 1921 Shaw received permission to make extensive tests on this; the work was carried out, in collaboration with E. Lancaster-Jones, in the basement of the Science Museum. In 1924–25 they carried out field tests with the torsion balance in Shropshire and at Hodbarrow, Cumberland, and were able to show its efficacy in the location and delineation of underground rock-structures. These experiments were the first of their kind to be carried out in Great Britain.

In 1928 Shaw and Lancaster-Jones designed their 'gravity gradiometer', a modified form of torsion balance designed specially for field-work and much smaller, lighter and quicker in operation than the conventional type of balance.

Shaw's interest in applied geophysics was a wide one, and by 1930 he was recognized as one of the leading authorities on the subject, with a world-wide reputation. Most of this geophysical work was carried out in his spare time, for he played his full part in the rapid development and extension of the Science Museum collections which took place during and after the occupation of the new building opened by H.M. King George V in 1928.

In 1931 Shaw was made a deputy keeper, and in 1935 he was promoted keeper of the Department of Physics and Geophysics. In 1940, in the absence on war service of the director, Colonel E. E. B. Mackintosh, he became acting director. In 1939 he had been put in charge of the A.R.P. arrangements in the Museum, and he also organised the evacuation to the country of the greater portion of the collections—a task of considerable magnitude and difficulty which he executed with great success. During the war period he also undertook several important geophysical surveys.

On Colonel Mackintosh's retirement in November 1945, Shaw succeeded him as director, and immediately threw himself with great energy into the task of rehabilitating the Museum collections. The Museum was partially re-opened in February 1946, and by the end of that year its post-war visitors had already totalled more than 1¼ millions. The task of full restoration of the Museum and its services to the pre-war standard was a heavy one, but it is satisfying to know that, within the limits imposed by the rebuilding programme, Shaw was able to lead and guide it practically to completion before his untimely death. Shaw expected good work from his subordinates, but never attempted to drive them at the pressure at which he drove himself. As director he was kindly and accessible, and concerned for the welfare of his staff of all grades.

Shaw's publications included a text-book of aeronautics (1918); various official handbooks of the

Science Museum; and about twenty papers in scientific journals, mainly on applied geophysics.

He was president of the Museums Association, honorary treasurer of the Physical Society, a trustee of the Imperial War Museum, a governor of the Imperial College and a manager of the Royal Institution.

He is survived by his widow; their only son died as a young man in 1946. F. A. B. WARD

WE regret to announce the following deaths:

Dr. P. N. Annand, chief of the Bureau of Entomology and Plant Quarantine, U.S. Department of Agriculture, on March 29, aged fifty-one.

Dr. Oskar Baudisch, director of research in the New York State Research Institute of Balneology and Hydrotherapy since 1934, known for work on cupferron and neo-cupferron as analytical reagents, on March 28, aged sixty-eight.

NEWS and VIEWS

University College of North Staffordshire: Prof. A. R. Gemmell

DR. A. R. GEMMELL, who was recently elected to the chair of biology in the University College of North Staffordshire, is thirty-seven years of age. He received his training in the University of Glasgow and later, as a Commonwealth Fund Fellow, in the University of Minnesota. Dr. Gemmell has a wide experience in biology, for he has held a post in the Forensic Science Department of the Home Office, a lectureship in plant pathology and physiology in the University of Glasgow, and he is at present lecturer in botany in the University of Manchester. His early research was in the field of plant pathology; recently he has turned his attention to bryophytes, and he has made original and interesting observations both on their physiology and on their geographical distribution. In Manchester, Dr. Gemmell has played an important part in broadening the scope of teaching in the faculty of science and in dealing with student affairs. Both in experience and temperament he is well equipped to take part in the ambitious experiment of founding a university with unusual aims and exceptional opportunities.

Dr. A. Mittasch's Eightieth Birthday

DR. ALWIN MITTASCH, whose eightieth birthday was celebrated recently in Heidelberg, is well known in the world of chemistry for his pioneering work on catalysis and his connexion with the Haber nitrogen-fixation process. Having studied catalysis under Ostwald, he became a collaborator of Carl Bosch in the Badische Anilinfabrik, Ludwigshafen, and after innumerable experiments he succeeded in discovering the suitable catalysing agents which made it possible to apply the Haber process commercially. Dr. Mittasch enjoyed for a long time the exceptional distinction of being a member of the Heidelberg Academy of Sciences without ever having taught at a university, and it was only on the occasion of his eightieth anniversary that he was awarded the title of professor. His far-reaching researches on catalysis have led him beyond the boundaries of chemistry; for example, he has made a deep study of the distinction between release causality, which is that observed in catalysis, and the ordinary mechanical causality—a distinction which was particularly emphasized by Robert Mayer. Altogether, he has written a number of books on chemistry and related subjects. One of his most recent works, "From Chemistry to Philosophy", which was published in 1948, is a collection of essays, the first part of which deals with catalysis in its widest aspect, the second with causality in Nature, and the third with Schopenhauer, Robert Mayer and Nietzsche. Probably Dr. Mittasch's most recent publication is an article on "The Other Nietzsche", which contains the following Nietzsche quotation: "The continuance of Christian ideals is one of the most desirable things. (Only the tyranny should stop.)"

Honours to Swedish Oceanographers

PROF. HANS PETTERSSON, director of the Oceanographical Institute, Gothenburg, has recently been awarded the Vega Medal of the Royal Geographical Society of Sweden and also the Galathea Medal of the Royal Danish Geographical Society. The former honour is named after the Swedish expedition in the *Vega*, which, with the explorer Adolf Erik Nordenskjöld as leader, was the first to sail through the North-East Passage in 1878–80, and the Medal is awarded annually in recognition of prominent achievements in the field of exploration. The latter, named after a Danish corvette which in 1845–47 circumnavigated the globe carrying a party of scientific workers engaged in geographical and oceanographical investigations, is awarded for services to these sciences. Prof. Pettersson is an internationally known authority on oceanography and was the leader of the Swedish Deep-Sea Expedition in the round-the-world voyage of the *Albatross* during 1947–48 (see *Nature*, **160**, 559; 1947, and **162**, 324; 1948); for this work he was awarded the Patron's Medal for 1949 of the Royal Geographical Society (of Great Britain) (see *Nature*, **163**, 595; 1949). His close associate and compatriot, Dr. B. Kullenberg, to whom is due the piston core-sampler which was the main tool on the *Albatross* expedition in the investigation of the deep-ocean floor, has been awarded the Wahlberg Gold Medal for his services to the cause of marine research. Previous recipients of this honour, which is given by the Swedish Society for Anthropology and Geography, include Sven Hedin and Erik Nordenskjöld.

Western Union Cultural Identity Cards

A CULTURAL identity card has been instituted by the Brussels Treaty Organisation, which will give certain facilities and privileges to nationals of each of the five Treaty countries when travelling in the other four for cultural purposes. In Article III of the Brussels Treaty, Belgium, France, Luxembourg, the Netherlands and the United Kingdom undertook to strengthen their cultural relations with each other. They have therefore made it one of their first tasks to encourage travelling and residence abroad by teachers, research workers, artists and men of science, for visits associated with the improvement of their professional knowledge or with research work. The

card can also be issued to students who have attended a university or other institute of learning for at least two years and have passed the usual examinations. The facilities and advantages offered are only a beginning. Until experience has been gained in the working of the scheme and to ensure that the advantages offered are not lightly granted, each country will issue only a limited number of cards. It is hoped gradually both to extend the facilities and to increase the number of holders.

The advantages and facilities offered in each country are printed in a handbook which will be issued with the card. The following examples, varying according to the country concerned, may be mentioned: free or reduced entry fees to museums and exhibitions; reduction in prices of tickets for concerts and theatrical performances; facilities for consulting libraries and archives; facilities for obtaining or prolonging residence permits; authorization to visit certain scholastic institutions and scientific establishments; admission to university restaurants; remission of fees at some educational and cultural institutions; facilities for obtaining foreign currency; and reduced transport rates. The card itself, which is identical in all five countries, is printed in the three languages, French, English and Dutch. It carries particulars of the holder, his passport number, photograph, etc., and an embossed stamp representing the Brussels Hôtel de Ville, and is valid for one year from the date of issue. The card will be issued free in the four Continental countries by the Ministries of Education (cultural identity card section), and in the United Kingdom by various authorities, a list of which can be obtained from the Foreign Office. In the case of scientific research workers not otherwise covered by any of the issuing authorities, application may be made to the Royal Society.

Technical and Technological Education

In his presidential address to the forty-first annual conference of the Association of Teachers in Technical Institutions on May 28, Mr. A. Taylor, of the Royal Technical College, Salford, after a passing reference to the bearing of revision of the Burnham salary scales on staff problems for the technical colleges and the danger of damage to education generally, urged that industrial leaders "should give whole-hearted support in erecting the alternative educational ladder: primary school, technical secondary school, college of technology. Only in this way, he said, would industry be able to recruit the high-grade personnel it needs, and to this end more technical secondary schools should be created and encouraged to take their entrants at eleven plus, and to continue their training until an age corresponding to that general in grammar schools. Mr. Taylor pointed out that national colleges have been set up in aeronautics, horology, rubber technology, foundry practice, and heating and ventilating and refrigerating technology, though some were housed in existing colleges, and the progress of these experiments would be watched with interest. He said further that the Association must be prepared to give the maximum support to whatever scheme of award to students on completing their training is eventually agreed. Mr. Taylor, however, drew no distinction between the training of technicians and that of technologists, and appeared to visualize no inherent obstacle save that of time to the development of technical colleges generally into technical universities. After commenting on the difficulties which attended the taking up of the scholarships offered to technical students by the Ministry of Education, of which in 1949 only 45 of the 100 awarded were taken up, Mr. Taylor referred to the need for more part-time teachers for evening work, so that the full-time teachers could devote more time to the increasing number of day students. For such teachers the technical colleges must look to industrial executives who have the right qualifications and experience. The quality of these part-time lecturers, he said, is a vital factor in technical education, and the Association's executive has given much time and thought to framing suitable salary scales for such teachers.

Education and Training of Laboratory Technicians

Of late it has become apparent in Great Britain that an increasing number of well-trained technicians are required for science laboratories of all types. In conjunction with this there is the need for laboratory technicians to be trained on the broadest lines and on a national basis, and for a certificate of proficiency to be instituted which will be a proof of status and be recognized throughout the country. In order to achieve this, the City and Guilds of London Institute has recently prepared regulations and syllabuses for a Laboratory Technicians' Intermediate Certificate Examination which will come into force at the beginning of the new academic year. The details for a Final Certificate Examination are still in the course of preparation. The Intermediate Certificate necessitates a three-year part-time course of approximately 180 hours a year at a recognized technical college or institute. Entrants for the course must be not less than sixteen years of age and have attained a reasonable standard in English, mathematics and science. The curriculum consists of three sections: science and drawing; general laboratory technique and organisation, including workshop practice; and specialized laboratory techniques. The first two sections are common for all students, while in the last only the one relevant part is taken. These specialized parts are: physics; chemistry; biology; combined physics, chemistry and biology; physiology and pharmacology; anatomy; animal housing; mechanical engineering; electrical engineering; and metallurgy. Further details of the whole scheme can be obtained from the Director, Department of Technology of the City and Guilds of London Institute, 31 Brechin Place, South Kensington, London, S.W.7.

British Chytrid Fungi

The morphology and life-history of seven species of aquatic Synchitriaceæ have been described by Hilda M. Canter (*Trans. Brit. Mycol. Soc.*, 32, Pt. 1, 69; 1949). They are mostly species of the genera *Micromyces* and *Microprycopsis*; but *Endodesmium formosum* is a new species in a new genus. It was found parasitic on *Netrium oblongum*, *Cylindrocystis crassa* and *C. brebissonii* growing in a sphagnum bog. *Micromyces lævis*, growing on *Mougeotia* sp., *Micromycopsis intermedia*, in *Zygnema* spp., and *Micromycopsis mirabilis*, parasitic in *Closterium* spp., are also described as new species. Another paper by the same author (*ibid.*, pp. 22–29) records two species of chytrids new to Britain—*Olpidium hyalothecæ* on *Hyalotheca mucosa* and *H. dissiliens*, and *Olpidium utriculiforme*, a parasite on *Closterium* spp. A two-stage parasitism is described in yet a third paper

(*ibid.*, pp. 16–21). *Chytriomyces* (= *Phlyctidium*) *tabellariæ* is parasitic on plankton (*Tabellaria* spp.) and is itself parasitized by *Septosperma anomalum*.

Visual Aids

THE increasing part which visual aids are playing in modern education has led manufacturers to produce a wide range of apparatus which can be used in this instructional technique. So many types of film-strip projectors, autoscopes, diascopes, epidiascopes, lanterns, micro-projectors, screens and wall fittings have made their appearance that educationists find it difficult to keep pace with the supply and to compare the relative merits of different pieces of equipment. For some time the need for a comprehensive list of existing visual aids has been evident, and the publication of a catalogue by the manufacturing firm of W. and J. George and Becker, Ltd., will be warmly welcomed in many quarters. It contains full details of almost every high-grade piece of equipment now available, and can be obtained from Nivoc House, 17–29 Hatton Wall, London, E.C.1.

Constitution of Alloys Group of the British Iron and Steel Research Association

THE Metal Physics Committee of the British Iron and Steel Research Association has appointed a Constitution of Alloys Group to consider the co-ordination of phase-diagram work being carried out in connexion with metallurgical subjects, especially the transitional elements and high-temperature alloys. The chairman of the Group is Prof. G. V. Raynor, professor of metal physics in the University of Birmingham, and there are thirteen members drawn from a wide field of research and industry. The Group will welcome inquiries and information from research workers and laboratories not represented by the membership of the Group. Communications should be sent to the British Iron and Steel Research Association, 11 Park Lane, London, W.1.

Cambridge Summer School in Automatic Computing

A SUMMER school in programme design for automatic digital computing machines is to be held during September 12–21 in the University Mathematical Laboratory, Cambridge. The course will give a basic training in the mathematical use of machines, dealing with the processes employed and their embodiment in programmes which specify the operations in detail. Lectures and practical classes will be held in the design of programmes for the Laboratory's electronic delay storage automatic calculator. Forms of application, to be returned by July 8, can be obtained from G. F. Hickson, secretary of the Board of Extra-Mural Studies, Stuart House, Cambridge.

Linnean Society of London: Anniversary Meeting

AT the anniversary meeting of the Linnean Society of London, held on May 24, the Linnean Medal was awarded to Mr. H. N. Ridley. The following were elected officers for the session 1950–51: *President*, Prof. F. E. Fritsch; *Treasurer*, Colonel F. C. Stern; *Secretaries*, Dr. B. Barnes (botany) and Dr. A. Tindell Hopwood (zoology); *Vice-Presidents*, Prof. G. D. Hale Carpenter, Mr. C. C. Hentschel, Mrs. Vera Higgins and Colonel F. C. Stern. The following were elected foreign members of Society: Rev. Father P. T. de Chardin and Prof. J. Feldmann (Paris), Prof. E. Gäumann (Zurich), J. Goossweiler (Luanda, Portuguese West Africa), Prof. S. O. Hörstadius (Uppsala) and Dr. R. Jeannel (Paris).

Royal Aeronautical Society: Awards

THE Royal Aeronautical Society has recently announced the award of the following medals and prizes: *Royal Aeronautical Society's Gold Medal*, the highest honour which the Society can confer for work in aeronautics, to Sir Geoffrey de Havilland for his outstanding work in the field of aviation; *Royal Aeronautical Society's Silver Medal* to Mr. W. E. Petter, for his work on the design of high performance aircraft, and to Mr. J. Smith, for his work on the design and development of high-performance R.A.F. and naval aircraft; *Royal Aeronautical Society's Bronze Medal* to Mr. A. C. Lovesey, for his contributions to engine development; *British Gold Medal*, for practical achievement in aeronautics, to Major F. B. Halford, for his outstanding work in the design and development of aircraft power plants; *British Silver Medal*, for practical achievement in aeronautics, to Mr. P. W. S. Bulman and Captain M. Summers, for their long and distinguished work in the flight-testing of aircraft; *George Taylor of Australia Gold Medal* to Mr. E. J. Richards, for his paper on "A Review of Aerodynamic Cleanness"; *Edward Busk Memorial Prize* to Mr. D. L. Ellis, for his paper on "Industrial Wind Tunnels"; *Usborne Prize* to Mr. C. M. Britland, for his paper on "Helicopter Hovering Performance"; *Simms Gold Medal* to Dr. D. E. Adams and Dr. A. N. Uttley, for their paper on "Navigational Systems and Instrument Aids"; *Pilcher Memorial Prize* to Mr. J. Hahn, for his paper on "Training of Aeronautical Engineers"; *Orville Wright Prize* to Mr. G. W. Trevelyan and Mr. D. R. Blundell, for their paper on "Determination of the Drag of Jet Propelled Aircraft in Flight"; *Branch Prize* to Wing Commander E. A. Harrop, for his paper on "Planned Servicing in the R.A.F.". *R. P. Alston Memorial Prize* to Mr. P. Goodman, for his valuable and careful work as a flight observer.

Announcements

THE Albert Medal for 1950 of the Royal Society of Arts has been awarded to Sir Edward Appleton, principal and vice-chancellor of the University of Edinburgh, "for outstanding services to science and industrial research". The Medal, which is the highest award in the gift of the Society, is given annually for "distinguished merit in promoting Arts, Manufactures and Commerce".

H.R.H. PRINCESS MARGARET will open an exhibition entitled "Metals in the Service of Mankind" at the Science Museum, South Kensington, London, S.W.7, on July 7. The exhibition has been arranged by the Institution of Metallurgists, and will be open to the public during July 7–September 30. A handbook containing a guide to the exhibits can be obtained (price 1*s.*, by post 1*s.* 2*d.*) from the Science Museum or from the Secretary, Institution of Metallurgists, 4 Grosvenor Gardens, London, S.W.1.

SIR WILLIAM STANIER has been appointed by the Minister of Supply to be chairman of the board of directors of Power Jets (Research and Development), Ltd.; he has been a director of Power Jets since 1944.

COPPER DEFICIENCY OF FRUIT TREES IN BRITAIN

By Dr. C. BOULD, Dr. D. J. D. NICHOLAS, J. A. H. TOLHURST and Prof. T. WALLACE, C.B.E.
Long Ashton Research Station, Bristol
AND
J. M. S. POTTER
National Agricultural Advisory Service, Royal Horticultural Society's Gardens, Wisley

A PATHOLOGICAL condition due to copper deficiency, known as exanthema, affects various fruit trees, including *Citrus* species and rosaceous trees. It was first recorded in *Citrus* in Florida so long ago as 1875; but it was not until 1928 that Smith and Thomas[1] reported it as occurring in French prune, Japanese plum, apple, pear and olive trees. Floyd[2] reported the beneficial effect of copper sulphate on *Citrus* trees in Florida in 1917, and this was later confirmed by Wickens[3] and Pittman[4] in Australia. Oserkowsky and Thomas[5] showed that the diseased condition of the leaves of Bartlett pears is associated with their copper content. Affected pear leaves showing exanthema contained 3·1–5·1 p.p.m. of copper, whereas normal leaves contained 11–20 p.p.m. of copper on a dry-matter basis. Copper deficiency in deciduous fruit trees has also been reported by Anderssen[6] in South Africa and by Dunne[7] in Western Australia. The latter refers to the disease as 'wither tip' or 'summer die-back'. Dunne states that brown spots, followed by necrotic areas, first appear on the terminal leaves; eventually the leaves wither and fall and the shoot finally dies. Application of copper sulphate, either to the soil or by injection into the trees, arrested the disease and the trees recovered. The copper content of healthy leaves varied from 5·5 to 12 p.p.m., whereas leaves from affected shoots varied from 1 to 3·6 p.p.m. of the dry matter. More recently, copper deficiency in tung trees has been reported by Droadoff and Dickey[8].

During the seasons 1948 and 1949, we have investigated a die-back condition of apple trees at the Royal Horticultural Society's Gardens, Wisley, and have been able to show that it is due to a serious deficiency of copper. The case appears to constitute the first recorded instance of this deficiency in fruit trees in Great Britain.

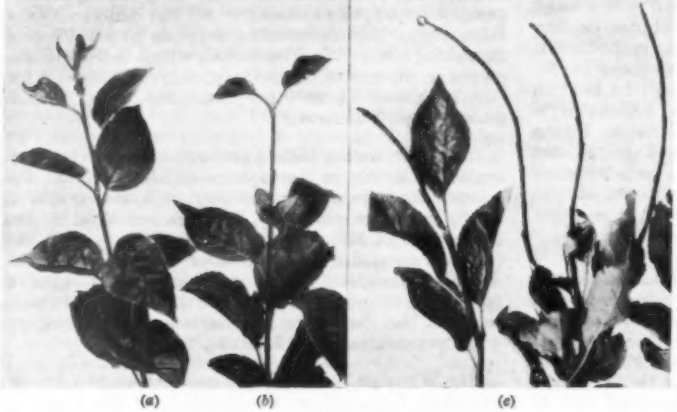
In July 1948 we investigated a serious failure of apple trees on the same plot at Wisley. We were able to show that the main trouble was due to a deficiency of zinc. A brief account of this work has been published in *Nature*[9]. At that time our attention was directed to quite different symptoms on the leaves and shoots of apple trees growing on Malling No. XII rootstock, which led us to suspect a deficiency of copper. The first symptoms appeared in early July on the terminal leaves of current-year shoots in the form of large irregular necrotic areas, and these were followed by upward curling and distortion of the leaves. The lower leaves on affected shoots were usually pale green, and sometimes exhibited numerous small irregular necrotic spots. One variety showed an irregular interveinal chlorosis; but this symptom was not general. Towards the end of July, the shoots began to shed their leaves from the tip downwards, and from September onwards they began to wither and die.

Table 1

Affected Wisley soils	Cu as μgm. per gm. air-dry soil: Soluble in cold 0·1 *N* HCl	*Aspergillus niger* method
Gloucester Cross area, 0–6 in.	1·6	2·0 (1948)
Crane's Seedling " 0–6 "	1·0	0·6 (1949)
" " " 6–12 "	0·9	0·2 "
Long Ashton soil (for comparison) 0–6 "	—	25·0 "

The site on which the trees are growing is low-lying and level. The soil is a coarse sand and gravel overlying deep gravel. The *p*H value of the surface soils varies from 6·5 to 7·5. Organic matter is low, varying from 1·8 per cent in the 0–6 in. layer to 0·5 per cent in the 6–12 in. layer. Citric-soluble P_2O_5 is high, ranging from 0·06 to 0·09 per cent in the 0–6 in. layer and falling to half this value between 6 and 12 in. Chemical and biological tests for copper gave the accompanying results (Table 1).

In July 1948, two trees of the apple Gloucester Cross, growing as half standards on Malling No. XII rootstock, were selected for treatment. These two trees were chosen because they had suffered from severe die-back for several years. On July 6 some branches were sprayed with a 0·1 per cent solution of copper sulphate (A.R.) and others injected with this material in powdered form. The copper spray caused some localized damage and slight defoliation of the older leaves, but at the end of the season the shoots were vigorous and healthy. Control untreated shoots lacked vigour and exhibited the typical symptoms previously described. Solid injection had only a slight beneficial effect in 1948.



(*a*) (*b*) (*c*)

Progressive onset of deficiency symptoms.

a, Growth restriction and necrosis of leaflets near growing point. *b*, Onset of defoliation of young leaves. *c*, Basipetal defoliation and die-back of shoots

In the following season, 1949, there was a slight residual effect from the foliage spray, but a very marked beneficial effect from the solid injection. Differences began to appear early in July, became more marked towards the end of the month, and were very pronounced by the end of September. Shoots on control branches lacked vigour, became defoliated from the tip and later died. Shoots on injected branches were very vigorous, carried normal healthy leaves and showed no signs of defoliation or tip die-back. Leaf samples from the middle region of the shoots were taken for analysis on August 30. The results for these samples and for samples from other varieties taken from trees at Wisley and Long Ashton are given in Table 2.

Table 2

Variety and treatment	Cu as μgm. per gm. of leaf dry-matter	
Wisley apples		
Crane's Seedling on *M*.XII	2·0	Diseased
Gloucester Cross on *M*.XII		
Control	2·2	,,
Sprayed 1948	2·4	,,
Injected 1948	5·1	Healthy
Cellini Pippin on *M*.XII	2·5	Diseased
Long Ashton apples		
Allington Pippin	6·0	Healthy
Lane's Prince Albert	5·7	,,
Edward VII	5·7	,,

The critical value for leaves from the middle region of terminal shoots appears to be below 5 μgm. copper per gm. of dry matter. These figures agree with those of Oserkowsky and Dunne.

In a second experiment started in 1949, using Crane's Seedling No. 856 on No. XII rootstock, which in previous years had shown tip die-back, all the copper treatments were effective in controlling die-back. Values for copper in the middle leaves sampled on August 30 from current-year growths are given in Table 3.

Table 3

Treatments February 16, 1949	μgm. of Cu per gm. of leaf dry-matter	
Soil application, ½ lb. $CuSO_4.5H_2O$ per tree	4·0	Healthy
Injection of copper salt at 1/5 $FeSO_4.7H_2O$ rate (ref. 10)	4·0	,,
Dormant spray, 2 per cent $CuSO_4.5H_2O$	3·2	,,
Control	3·0	Diseased

The visual symptoms and leaf and soil analyses, together with the response to copper treatment, show that a serious deficiency of copper is responsible for the die-back condition of the trees. An interesting feature of this case is that the trees most seriously affected are on Malling No. XII rootstock, which is regarded as the strongest of the Malling clonal rootstocks. Comparable trees on Nos. I and II are less affected, and it would appear that No. XII is particularly susceptible to a deficiency of copper in the soil.

Further experiments are in progress on apples and pears and will be fully reported elsewhere.

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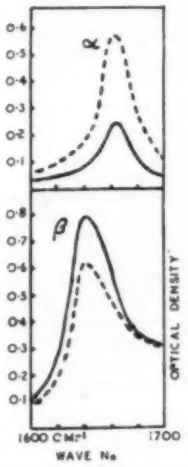
STRUCTURE OF SYNTHETIC POLYPEPTIDES

By Dr. A. ELLIOTT and E. J. AMBROSE

Courtaulds, Ltd., Research Laboratory, Maidenhead

WE have recently examined the polarized infra-red spectra of several new polypeptides prepared in this Laboratory by Hanby, Waley and Watson. These materials, when prepared from solvents which give the α-folded form[1], can be very highly oriented. When they are cast from formic acid, which gives the extended β-form of polypeptide chain, the orientation which we have been able to produce is low.



Infra-red absorption band of the peptide C = O bond in oriented D-L-phenyl alanine L-glutamic methyl ester copolymer (1 : 1). α, film cast from *meta*-cresol; β, film cast from formic acid. Electric vector of absorbed radiation perpendicular to chain axis of molecule, full line; the vector parallel to chain axis, broken line

Poly-L-glutamic benzyl ester shows (in addition to the ester C = O band) a single C = O band at 1,659 cm.$^{-1}$ with strong parallel dichroism; it appears from X-ray evidence to be entirely in the α-form. In the methyl ester, however, the peptide C = O band has two components (1,658 cm.$^{-1}$ and 1,629 cm.$^{-1}$ respectively) when the polymer is cast from *m*-cresol, indicating two phases. The low-frequency component shows no orientation. When the methyl ester is cast from formic acid, only the 1,629 cm.$^{-1}$ component is present. We therefore identify the 1,658 cm.$^{-1}$ and 1,629 cm.$^{-1}$ components of the C = O band with the α- and the β-forms, respectively. Although we have not succeeded in orienting the β-form of poly-L-glutamic methyl ester, our assignment has been confirmed on a co-polymer of this material with D-L-phenyl alanine, which can be oriented in both α- and β-forms. In the co-polymer, the C = O components are at somewhat higher frequencies, namely, 1,642 cm.$^{-1}$ and 1,665 cm.$^{-1}$. These components show respectively perpendicular and parallel dichroism, as may be seen in the accompanying diagram.

It is found that the N—H deformation mode has two frequencies, 1,527 cm.$^{-1}$ and 1,550 cm.$^{-1}$, showing

parallel and perpendicular dichroism, corresponding to the β- and the α-forms. The N—H stretching mode at 3,305 cm.$^{-1}$ does not show two peaks; but there does appear to be a very small frequency-difference in this band in the methyl ester α- and β-forms. The doubling of the C=O stretching and N—H deformation frequencies gives a method of distinguishing between α- and β-forms in unoriented and amorphous materials, and offers considerable possibilities for the study of the denaturation of proteins.

The weak N—H stretching mode at 3,060 cm.$^{-1}$ is masked in the benzyl ester by aromatic frequencies but shows perpendicular and parallel dichroism, respectively, in the β- and α-forms of other polymers. The origin of this band has been considered by Darmon and Sutherland[2], who have suggested that it is associated with the formation of chelate rings. We are inclined to attribute the multiplicity of peaks in the NH stretching mode (for example, five peaks are observed in acetanilide in the solid state) not to multiplicity of structures, but to the various normal modes of vibration of the sequence of coupled oscillators

N—H . . . O=C—N—H . . . O=C

which occurs in α- and β-forms of polypeptides and proteins, and in polyamides. This belief is strengthened by our recent observation that the weak N—H band is itself complex, with at least three peaks the relative intensities of which differ in the α- and β-forms of the polypeptide. It should be noted that, in our experience, the type of dichroism shown by the strong 3,305 cm.$^{-1}$ and by the weak 3,060 cm.$^{-1}$ band is always the same. In this respect it is quite different from the doubling of the C=O stretching and the N—H deformation bands referred to above.

The extremely high value of the dichroic ratio for the NH bands (1 : 14) in poly-L-glutamic benzyl ester does not necessarily mean that the N—H bond is strictly parallel to the chain axis. The direction of dipole moment change may correspond more closely to that of the direction of the H · · · O hydrogen bond rather than that of the N—H bond, for the hydrogen bond doubtless contributes to the dipole moment and the N—H · · · O=C atoms may not be co-linear. The direction of dipole moment change in the C=O bond may be also affected, though probably to a smaller extent, by the hydrogen bond. The observed C=O dichroism is, in fact, somewhat greater than we should expect in the α-fold referred to below.

We have observed that poly-L-glutamic benzyl ester or poly-D-L-phenyl alanine in dilute solution (less than 1 in 1,000) in chloroform shows the NH band at 3,305 cm.$^{-1}$. At this concentration, interchain bonding can play no important part; nevertheless, no *free* NH band (which occurs at about 3,460 cm.$^{-1}$) is observed. This is in contrast to results obtained with a polymer containing C=O and N—H groups in the side-chains as well as the main chain (poly-carbo-benzoxy-D-L-lysine). In this material, only the hydrogen-bonded N—H band (3,295 cm.$^{-1}$) appears in the solid film. In dilute solution, however, the unbonded N—H frequency at 3,461 cm.$^{-1}$ is observed in addition. These observations show that the dilution is sufficient to destroy the inter-chain bonding.

We may certainly conclude that in the α-fold (into which the molecule goes in dilute solution in inert solvents) all the hydrogen bonds of the peptide link are intra-molecular. It is of interest to note that Mizushima *et al.*[3] have shown that the N—H · · · C=O frequency in a seven-membered ring has an absorption frequency of 3,330 cm.$^{-1}$.

Photographs of the highly oriented α-folded films of poly-glutamic esters have been obtained by Dr. F. Happey in Courtaulds' X-ray Laboratory. They show a very high degree of crystallinity. The methyl ester photograph shows a considerable resemblance to the photograph of dried muscle obtained by Lotmar and Picken[4]; it shows a meridian arc at 2·6 A. but *not* at 5·2 A. This indicates a two-fold screw axis with 5·2 A. repeat distance, and strongly supports the α-fold suggested by Ambrose and Hanby[6] for this polymer. The benzyl ester photograph is similar, but it does show a meridian arc of 5·2 A.

It is scarcely conceivable that the folding of the peptide chains in the two esters would differ, since the remaining X-ray reflexions correspond, and the infra-red α-frequencies are identical within experimental error. The presence of the 5·2 A. arc (which would not appear if the molecule had a two-fold screw axis) must be attributed to unsymmetrical packing of the larger side-chains. The evidence from X-ray photographs will shortly be reported in detail by Bamford, Hanby and Happey.

If the above conclusions be allowed, the presence of a 5·2-A. meridian spacing in the fibrous α-proteins cannot be held to be incompatible (Astbury[8], Brill, quoted by Zahn[7]) with the α-fold suggested by Ambrose and Hanby. Because of the great similarity between synthetic polypeptides and fibrous proteins (X-ray diffraction, infra-red spectra and occurrence in extended and folded forms) we think that the observations and deductions described above answer, in great measure, the criticisms which Astbury[8] and Darmon and Sutherland[2] have directed against earlier work from this Laboratory[5,9]. Astbury's view that a transition from an α- to a β-type of protein must be accompanied by a 100 per cent chain extension is not shared by other workers[10,11], who have interpreted their experiments on the stretching of wool as showing that the extension is much less than 100 per cent. Zahn[7] and Simanouti and Mizushima[12] have, for other reasons than ours, suggested the same fold for α-proteins put forward by Huggins[13] and modified by Ambrose and Hanby[5]. These papers, owing to the difficulty of getting German and Japanese journals, had not been seen earlier by us. The model proposed by Mizushima *et al.*[3] for α-keratin, consisting of a mixture of extended and folded forms, would give perpendicular dichroism of the N—H stretching and C=O stretching frequencies, and is not compatible with our results.

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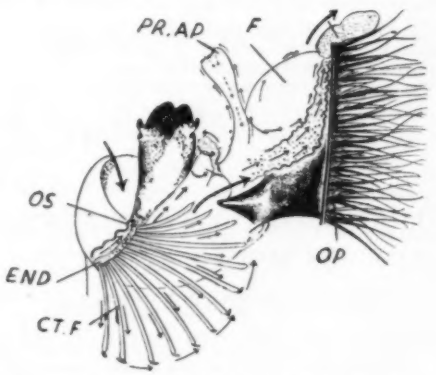
FEEDING MECHANISMS IN THE VERMETIDÆ (ORDER MESOGASTROPODA)

By J. E. MORTON

Department of Zoology, Auckland University College, University of New Zealand

CILIARY mechanisms of food-collecting by employment of the currents of the ctenidium and pallial cavity have been described in several families of style-bearing prosobranchs: the Calyptræidæ, Capulidæ and Vermetidæ as reviewed by Yonge[1], the Turritellidæ (Graham[2]) and recently in the Struthiolariidæ (Morton, 1949, in the press). A study of the biology and feeding mechanism of the New Zealand representatives of the Vermetidæ has helped to throw further light on the relationships of this group. The family contains at least two separate series of sessile gastropods, superficially alike in structure, but probably having separate origins among free-moving, regularly coiled prosobranchs. To the first series may be assigned all the vermetids hitherto investigated in life, including '*Vermetus*' *gigas* (Boettger[3]), '*Vermetus*' *novæ-hollandiæ* (Yonge[4]) as well as *Bivonia triqueter*, species of *Aletes*, *Petaloconchus* and *Spiroglyphus*, and finally *Serpulorbis zelandicus* examined by me. To the second series belong the smaller operculate vermetids of the genus *Stephopoma*, typified by the neozelanic *S. roseum*, as well as the siliquariid vermetids represented in New Zealand by *Pyxipoma weldii*. The genus *Vermicularia*, of which the animal is at present uninvestigated, is likely also to form part of this series.

Yonge and Iles[5] stressed the contrast between '*Vermetus*' *gigas* and '*Vermetus*' *novæ-hollandiæ*; the two forms were considered—on the basis of their widely differing feeding mechanisms—to belong to separate sections of the family. *V. novæ-hollandiæ* is exclusively a ciliary feeder, occurring in a wave-beaten exposed environment; *V. gigas* lives in calm water and subsists entirely on food captured by mucous strings extruded by the highly developed pedal gland. *Serpulorbis zelandicus* is of interest in showing an intermediate stage between the two extreme conditions of *V. novæ-hollandiæ* and *V. gigas*. It is predominantly a ciliary feeder, living on moderately exposed rocky shores, subject to a good deal of wave surge. The gill is prominently developed, its relative size being about the same as in *V. novæ-hollandiæ*. The filaments remain primitively triangular, but are powerfully ciliated, and there is a strong inhalant pallial current. The hypobranchial gland is well developed, but an endostylar tract along the gill axis has not been acquired. Along the right side of the pallial cavity runs a well-developed ciliated and glandular food tract, carrying collected particles forward to the mouth. The pedal mucus gland is much larger than in *V. novæ-hollandiæ*, of almost the same relative size as in *V. gigas*, and *Serpulorbis zelandicus* possesses a supplementary mode of food-collecting by means of thread-like mucous traps. These are, however, never so long or well developed as in *V. gigas*, and their formation is difficult to induce in laboratory tanks; they were best seen immediately on collecting the animal, by turning over rocks at low spring tide, when thin filaments of mucus were at times discovered protruding from the aperture of the pedal gland. Other vermetids, such as species of *Aletes*, *Spiroglyphus* and *Bivonia*, show various intermediate conditions between *V. novæ-hollandiæ* and *V. gigas*, and it is evident that all are members of a series fundamentally alike in the specialization of the pedal gland and pedal tentacles, in digestive, reproductive and other structural features. *V. novæ-hollandiæ* probably represents a more primitive level of this section of the Vermetidæ; the mucus-feeding habit has either never been acquired or possibly was lost at an early stage owing to the rough-water environment. In other genera, mucous-trap feeding replaces ciliary feeding in varying degrees, with consequent reduction in size of the gill and food groove, culminating in the '*Vermetus*' *gigas* stage, where the ctenidial food-collecting mechanism is lost altogether. A parallel trend appears to be the reduction in size of the crystalline style and gastric shield; and it is significant in this respect that *V. gigas* is reported to feed largely upon zooplankton and other minute animal food.



Stephopoma roseum. Diagram of head, foot and pallial region, showing fringe of ctenidial filaments extruded for sweeping action described in text. *CT.F*, ctenidial filaments; *END*, endostyle; *F*, foot; *OP*, operculum; *OS*, osphradium; *PR.AP*, pre-oral appendage of foot

The second section of the vermetid assemblage, comprising the genus *Stephopoma* and the siliquariid genera, shows fundamental differences from the mucus-feeding vermetids. *Stephopoma* forms large agglomerated masses, near low spring tide, and is ecologically equivalent to the serpulid worms. Most of the siliquariids, including *Pyxipoma weldii*, form long, loosely spiral tubes, embedded in sponges in sub-tidal locations. These genera are found to be closely related, and to have only a loose association with the vermetids hitherto investigated. There is no specialized pedal mucus gland, the pedal tentacles are absent, and mucous strings are never formed. The mode of feeding is primarily by ciliary means. The ctenidium is much more highly adapted than in the previous vermetids; the filaments are long, slender and rod-like, attached to the mantle only at the base, and approaching the condition typical of *Crepidula* (Orton[6]). The endostyle is a well-developed glandular strip, and there is a deep food groove, where collected particles are elaborated into a mucous cord, periodically plucked off by the radula. More interesting is the development in *Stephopoma roseum* of a sweeping net-feeding mechanism, to supplement the collection of particles within the mantle cavity (see diagram). The anterior fourth of the gill can be

widely protruded from the pallial cavity, and its narrow filaments radiate to form a semi-circular fringe of cirrus-like rods. This is extended over the mantle border and intermittently drawn through the surrounding water like the feeding-net of a cirripede or a serpulid, though in a much more leisurely manner. Mucus is provided by the cells of the endostyle, along the gill axis, and is carried by the frontal cilia to the tips of the filaments, together with particles coming into contact with the extended fringe. Long tufts of apical cilia carry the mucus around the circumference of the fringe, to a position near the opening of the food groove, where collected particles may be either ingested or rejected. In view of the closely aggregated occurrence of *Stephopoma* in continuous masses, this feeding adaptation, the first of its kind recorded among the Gastropoda, is a most efficient method of exploiting the widest possible feeding area, after the manner of both the cirripedes and the serpulid worms.

A fuller account of the biology and structure of these vermetids is shortly to be published.

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THE CARNEGIE INSTITUTION OF WASHINGTON

ANNUAL REPORT FOR 1948–49

YEAR Book No. 48 of the Carnegie Institution of Washington* includes the usual reports of the executive committee, auditors and president, Dr. Vannevar Bush, for the year ended June 30, 1949, together with the departmental reports and a bibliography of publications of the Institution for the year. The presidential report, reviewing particularly the position of the senior investigators on the staff of the Institution, stresses the absence of pressure for periodic publication as one reason for the enthusiasm of the scientific staff. Their performance is assessed by the consensus of opinion of colleagues and investigators in the same general field without any such pressure towards premature or regular publication. The Institution does not use the organised group attack to any extent; but nevertheless staff opinion expects the individual pursuing his own line of research so to select his problems and conduct his work as to reflect favourably upon the progress of the work being conducted by his colleagues in adjacent areas. Dr. Bush points out that the Institution differs from a university in the freedom of its staff from the distraction of other duties; but their isolation from teaching and from youth generally may be an obvious drawback if care is not taken to offset that isolation by participation in the scientific affairs of the nation or attendance at scientific meetings. The fellowship programme of the Institution is also planned to bring in young scientific workers on a temporary basis and also to invite as guests others who are of high standing in the scientific world.

Reviewing the research activities, Dr. Bush points to the initiation of scientific observations by the great Hale 200-inch telescope and the 48-inch Schmidt camera at the Palomar and the Mount Wilson Observatories. Both instruments are the largest of their type yet constructed and will be a powerful asset for astronomical research. A survey of the southern sky for several types of rare stars, which has been carried out for more than thirty years, was completed during the year and has led to the discovery of some fourteen hundred emission-line stars, mostly of class B, and about two hundred new planetary nebulæ. Investigations at the Geophysical Laboratory are now focused sharply on the formation and properties of rock-forming minerals with and without the presence of mineralizers, such as water, for the general purpose of understanding the complex processes by which the earth was formed. Besides the study of anhydrous silicates, including the inversion characteristics of quartz, the Laboratory has studied the behaviour of silicates in presence of water under pressure and has found that the sodic form, albite, may exist in either of two different modifications depending on the temperature of formation, and that solid solutions existing at high temperatures sometimes unmix at lower temperatures.

The Department of Terrestrial Magnetism has concluded a series of experiments, on the maintenance of the earth's electrical charge, in which measurements in the clear air high above thunderstorms have shown that in such localized areas the electric current between the upper atmosphere and the ground is reversed in sign to the fair-weather current and is greatly increased in intensity. Important information has also been obtained on the origin of cosmic rays, while in nuclear physics the major emphasis has been on the problem of proton–proton scattering in the relatively low-energy region of 200–500 kV., using the 1-MV. electrostatic generator. The biophysics programme continues to be evolved; but the work during the year has been largely concerned with metabolic and physiological studies using radioactive isotopes, and with studies of biological effects of radiation, including a comparison of the permeability of *Escherichia coli* to sodium and potassium ions and the biochemical function of potassium. The Division of Plant Biology has found, in its studies of photosynthesis, that the activity of colloidal solutions of chloroplast material obtained by ejection of suspensions through a needle valve at high pressure is greatly increased by the aggregation of the colloidal particles on addition of salt solutions in the presence of dilute methyl alcohol, and that only the light which is absorbed by photochlorophyll can lead to chlorophyll formation by corn and bean seedlings which have been grown in darkness. In co-operative experiments the climatic adaptability of *Poa* hybrids has been tested over a wide range of conditions, and some grass hybrids were selected for quantitative trials of their growth response in controlled laboratory experiments.

The Department of Embryology has continued its collection, preparation and study of human embryos as well as its studies of the physiology of the uterus, the blood vessels of the pregnant uterus, the permeability of blood capillaries and of the human placenta and the physiology of menstruation. In the Department of Genetics further evidence has been obtained

* Carnegie Institution of Washington. Year Book No. 48, July 1, 1948–June 30, 1949; with Administrative Reports through December 9, 1949. Pp. xxxvi+258. (Washington, D.C.: Carnegie Institution, 1949.)

that the unit of heredity, a gene locus, may control several reactions; and, working with maize, use of a special technique has brought an unstable gene into proximity with a stable gene locus, thus permitting a fuller analysis of the composition and action of the normal locus. Studies of the genetics of the resistance to streptomycin of *Escherichia coli* have indicated that what appears to be a single gene locus controls a series of reactions, and the reverse changes in locus are probably not brought about through a reversal of the original chemical reaction, but through some other change in the same gene locus. The bacterial resistance to aureomycin, chloromycetin and neomycin, the mutagenic action of chemicals on the sperm of *Drosophila*, the cytology of bacteria, the organisation of the chromosome, the genetic structure of natural populations among tropical *Drosophila*, and intracellular growth and genetics of bacteriophage have all received attention, while the analysis of the mechanism of action of individual genes has continued. In mouse leukæmia evidence has been obtained that the age of the mouse has as certain an influence on the incidence of spontaneous leukæmia after birth and on the length of life as has the age of the mother before birth. In the Division of Historical Research studies have continued on the early cultures in the Guatemala highlands, of ceramic technology and of the ceramic sequences of the lowland Maya area in eastern Campeche.

PROF. F. SEVERI'S SCIENTIFIC JUBILEE

THE year 1949 marked two events of cardinal importance to mathematics: the centenary of the *Annali di Matematica*, and the seventieth birthday of Prof. Francésco Severi, director of the Istituto Nazionale di Alta Matematica, Rome, and for many years the chief editor of the journal. It thus seemed peculiarly appropriate to Prof. Severi's colleagues that a celebration should be organised to commemorate the double event; accordingly, a national committee was formed, under the chairmanship of Senator G. Castelnuovo, to consider what steps might be taken to this end.

It was then decided: to offer the *Annali* for the year 1949–50 in homage to Prof. Severi, and to invite contributions from representative mathematicians, of all nationalities, to this number; to initiate the publication of Prof. Severi's selected papers in four volumes, arranging to complete the first volume in time for presentation at a ceremony to occur later in the year; and to found a commemorative scholarship at the Institute. To these projects was afterwards added a fourth, namely, the expansion of the ceremony, as originally planned, into a miniature international congress, at which foreign mathematicians should be invited to participate, thereby lending an additional and general interest to the occasion.

Eventually it proved expedient to postpone the proceedings to 1950, again a significant year, as marking the half-century of Prof. Severi's scientific activity. The date finally fixed for the ceremony was April 25, and the place the Aula Magna of the Institute. The ceremony opened, at 10.30 a.m., with *éloges* pronounced by Senator Castelnuovo and the Rector of the University. Then followed a discourse by Prof. G. Sansone, of Florence, who, in his capacity of co-director of the *Annali*, gave a brief history of the journal and presented the three current volumes to Prof. Severi. The fourth leading speech was made by Prof. B. Segre, of Bologna, who, as editor of the "Collected Papers" and with the authority of the master's most distinguished pupil, illustrated the author's scientific achievements, particularly in the field covered by the first volume. To these addresses Prof. Severi replied in simple and moving terms.

On the same evening, a reception was given by Signora and Prof. Severi at their home, at which many Italian mathematicians and notabilities, as well as the foreign guests, were present.

The Congress proper opened on the morning of April 26 and continued, with two daily sessions, until April 28. The speakers were drawn from many European countries, including Poland and also the U.S.S.R., of which the delegation of four was led by Prof. P. S. Alexandroff. From the British Isles came Prof. A. S. Besicovitch, Prof. L. J. Mordell, Mr. L. Roth, Prof. J. G. Semple and Prof. J. L. Synge, all of whom made communications. The opening address was given by Prof. W. Sierpinski, of Poland; about twenty papers were read, covering such topics as algebra, the theory of aggregates, number theory, functions of a real or complex variable, algebraic and differential geometry, topology, differential equations, mechanics and electrodynamics. While some of the papers (in Italian, English, French or German) were of the usual congress type, reporting developments in a selected field, most of them represented original work, some of it actually written for the occasion. It is impossible to give further details here, and it must suffice to note that the University of Rome intends to publish the proceedings in a special volume of the *Rendiconti* of its mathematical seminar, which will include also an account of the ceremony of April 25; this should be available in the near future.

During the three days of the conference the authorities of the University and the City continued their hospitality. On the afternoon of April 27 the Accademia Nazionale dei XL gave a reception in the beautiful cloisters of the Museo delle Terme, which at the same time provided an opportunity of viewing some of the finest extant specimens of Greek and Roman sculpture. Other receptions were held by Profs. E. Bompiani and M. Picone. On the evening of April 28 Signora and Prof. Severi gave a dinner at the Grand Hotel to their foreign guests, who were thus afterwards enabled to express publicly their thanks and to tender their good wishes to the host and hostess.

On April 29 the visitors made their way to Arezzo, Prof. Severi's birthplace, where a civic reception, a presentation by the Accademia Petrarca and other celebrations followed. The next day a whole programme of tours and ceremonies was carried out in the neighbouring country of the Casentino, culminating in an oration by Prof. Severi on Dante, in reply to his election as honorary member of the Dante Society of Bibbiena.

So ended a series of festivities, spiritual and worldly, which none of the participants is ever likely to forget. The kindness and generosity of the organisers, and the smooth working of the programme in all its details, will leave an indelible imprint; while to the newcomers to the scene an eminent mathematician has been revealed as a great, indeed a paramount, personality.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Enzymic Formation of *nor*Adrenaline in Mammalian Tissue Extracts

THE possibility that *nor*adrenaline carboxylic acid, 3,4-dihydroxyphenylserine, might be a precursor of adrenaline has been suggested previously[1]. Recently, it has found experimental support[2]. Experiments carried out in Oxford[3] have shown that lævo-*nor*-adrenaline was formed when the amino-acid was decarboxylated by bacterial preparations; but no similar reaction was observed in mammalian tissue extracts.

Another specimen of dihydroxyphenylserine has recently been examined in Glenolden; it was found that it gave rise to a pressor substance and carbon dioxide when incubated with mammalian tissue extracts. Too little of the material was available for a full analysis of its stereochemical configuration and of the exact nature of the pressor agent formed.

These findings have led to a re-examination in Oxford of the specimen used in the earlier work (prepared by Dalgliesh and Mann[4]). A slow formation of carbon dioxide was observed when the amino-acid was incubated anaerobically with extracts of guinea pig's kidney. The incubated extracts were assayed on the spinal cat; arterial blood-pressure and contractions of the nictitating membranes were recorded. The results indicate that the amine formed was lævo-*nor*adrenaline. Similar results were obtained with another specimen of the amino-acid previously used by Guggenheim[5] (and kindly put at our disposal by Messrs. Hoffman La Roche, of Basle). These observations strongly suggest that the substance used in Glenolden also had the same configuration and that the amine formed was also *nor*adrenaline.

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Effect of Aeration on the Cytochrome Systems of the Resting Cells of Brewers' Yeast

BREWERS' yeasts have a lower respiration and, usually, a higher fermentation than bakers' yeasts. The absorption spectrum of their cytochrome differs from the typical four-banded spectrum of bakers' yeast[1] in showing only two distinct bands in the visible region[2]. By increasing the oxygen supply during growth, their absorption spectrum was changed into that of 'bakers' yeasts'[3]. Similar changes have also been noticed in *Aspergillus oryzæ*[4]. Since all these experiments were conducted under the conditions which allow cell proliferation, it was naturally considered that the observed changes were due to a selection of certain cells, the multiplication of which was favoured by aeration.

In the present communication, it is shown that an alteration both in the cytochrome components and in the metabolic activities can be demonstrated during resting metabolism of brewers' yeasts, thus excluding the possibility that certain cells were selected during the process. For this study, top fermenting brewers' yeast, 36–48 hours old, was obtained from a local brewery (Greene King). Microscopic examination with Methylene Blue (1 : 10,000 at *p*H 5·5) showed that the number of dead cells was negligible. The yeast was washed twice with distilled water and once with phosphate buffer, and suspended in *M*/15 phosphate buffer, *p*H 5·5, containing 0·04 per cent magnesium sulphate ($MgSO_4.7H_2O$) and 2 per cent glucose. Suspensions were then aerated at 30° C. in a plugged glass cylinder to the bottom of which was fused a sintered glass disk of the same diameter (6·5 cm.) as the cylinder. Similar suspensions, serving as controls, were incubated at the same temperature without aeration. Samples were taken out at intervals for spectroscopic and manometric experiments. Throughout the whole period of the experiments no contamination was observed microscopically. Very few dead cells were found during an 8-hour incubation, but the number tended to increase after twelve hours.

Spectroscopic examination. Examination of the cytochromes of the top brewers' yeast with a micro-spectroscope showed the α-bands of two cytochromes: b_1, asymmetrical and lying at 550–566 mμ, and a_1, weak and very diffuse at 585–590 mμ. The corresponding β-bands were generally diffuse and lying at 521–538 mμ with a maximum around 530 mμ. When a suspension of the yeast was cooled in liquid air, the b_1-band split into three components: (1) a very strong *b*-band at 560 mμ, (2) a weak, narrow *c*-band at 548 mμ, and (3) a very weak *e*-band[5] at 556 mμ, while the β-bands also sharpened into two clearly separated bands at 530 and 519 mμ.

After two hours aeration, spectroscopic examination at room temperature showed that the b_1 band had split into *b*- and *c*-bands at 560–566 and 550 mμ respectively, the latter band being the stronger. The diffuse background to *b* and *c* persisted, as did also the band a_1, although this had in part been replaced by a narrow *a*-band at 605 mμ. After four hours aeration the *c*-band became very much intensified, while the *b*-band diminished to a weak shadow. The *a*-band was now fairly strong but there was no trace of *e* or of a_1, except after cooling in liquid air, when *e* could just be detected. The maximum of the β-bands had shifted from 530 to 521 mμ. Two more hours aeration caused no further change in the general spectral pattern, but the intensities of *c*, and especially of *a*, increased to a maximum value. The resulting spectrum of the transformed yeast was now quite similar to that of an ordinary bakers' yeast, except that the *b*-band was somewhat weaker. In unaerated controls the bands remained unchanged. Efforts to change the resting transformed yeast back into its original state by resuspending the transformed cells in the same

EFFECT OF AERATION ON THE RESPIRATION AND FERMENTATION OF BREWERS' YEAST

Yeast	Treatment	Time of treatment (hr.)	Q_{O_2}	$Q_{CO_2}^{N_2}$
Top brewers' yeast	—	0*	67	281
	Aerated	4	100	219
	Non-aerated		69	290
	Aerated	8	108	152
	Non-aerated		68	295
	Aerated	20†	100	96
	Non-aerated		56	243

* Samples were taken from the non-aerated suspensions after ½-hr. incubation.
† Suspensions containing 5 per cent glucose as substrates were employed for the treatment.

glucose–phosphate solution and incubating at 30° C. under both anaerobic and the above 'control' conditions were without success. However, when partially changed yeast cells showing *c*- and *b*-bands of the same intensity were incubated under the same conditions as the controls, the original broad and asymmetrical b_1 replaced *b* and *c* within two hours.

Manometric experiments. The results of manometric experiments carried out at 37° C. and summarized in the accompanying table indicate that, after eight hours treatment, while the non-aerated cells of the top brewers' yeast maintained a practically constant respiration and anaerobic fermentation, aerated cells showed an approximately 60 per cent increase in oxygen uptake and a 50 per cent decrease in carbon dioxide output. The oxygen uptake of both aerated and unaerated cells was inhibited almost completely by either *M*/800 potassium cyanide or *M*/500 sodium azide. In an atmosphere of carbon monoxide and oxygen ($CO/O_2 = 19$), the respiration of aerated cells was inhibited by 80 per cent and that of unaerated cells by 60 per cent when compared with controls in a gas mixture of the same oxygen tension ($N_2/O_2 = 19$); this inhibition was light-sensitive.

When yeast suspensions were aerated in the presence of sodium azide (*M*/500) for four hours, the absorption intensities of the original cytochromes, and the oxygen uptake and carbon dioxide output of the cells decreased irreversibly to a considerable extent. Further aeration experiments were also carried out in the presence of the following substrates: sucrose, succinate, lactate, glycerol, pyruvate, ethyl alcohol and acetate. All except sucrose were less effective than glucose in the transformation of cytochromes, succinate and glycerol being the least so.

The results recorded above indicate that, in the non-multiplying cells of brewers' yeast, an increase in the oxygen supply (aeration) can produce parallel changes in both the cytochrome components and the respiratory character within fairly short periods. Apparently the formation of new cytochrome components takes place at the expense of other components of the same system. The fact that it is possible by aeration to bring about fundamental changes in the respiratory systems of resting cells, adapted during countless generations to a well-defined mode of life, appears to offer a new line of approach for studying the function of these important oxidizing catalysts in living organisms.

I wish to express my appreciation to Prof. D. Keilin for his constant interest and advice. I also wish to thank Dr. E. F. Hartree for reading the manuscript and the British Council for a scholarship.

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Nature of Placental Cholinesterase

IN the course of a study of the types of cholinesterase occurring in different mammalian tissues, we have examined the ability of both fresh and perfused human placentas to hydrolyse acetyl choline, acetyl-β-methyl choline and benzoyl choline. Torda[1] had previously shown that perfused, blood-free placental tissue hydrolysed acetyl choline; but she did not report on the specificity of the enzyme in this tissue. Typical results which we have obtained using Mendel, Mundell and Rudney's "specific" substrates[2] are given in the accompanying table. Enzymic activity has been measured by the Warburg technique using homogenized preparations of fresh and perfused placentas; in the latter case, the tissue was perfused with tap-water through the umbilical vein until the effluent fluid was no longer visibly blood-stained.

HYDROLYSIS-RATES OF ACETYL CHOLINE, ACETYL-β-METHYL CHOLINE AND BENZOYL CHOLINE BY FRESH AND PERFUSED HUMAN PLACENTA

	μl. CO_2/gm./hr.			As % of acetyl-choline activity	
	Acetyl choline (0·015 *M*)	Acetyl-β-methyl choline (0·03 *M*)	Benzoyl choline (0·015 *M*)	Acetyl-β-methyl choline	Benzoyl choline
Fresh	420	169	50	40	12
	412	198	68	48	17
	1110	370	239	33	22
	742	284	173	38	24
	—	—	—	—	—
	Mean:				
	671	255	132	40	19
Perfused					
	155	66	6	42	4
	175	121	11	69	6
	274	162	16	59	6
	220	121	24	55	11
	186	84	0	45	0
	—	—	—	—	—
	Mean:				
	202	111	11	55	5

It will be seen that whereas fresh placenta (with its contained blood) hydrolyses both acetyl-β-methyl and benzoyl choline, the perfused blood-free tissue shows only negligible activity in the presence of the latter substrate, while still hydrolysing acetyl-β-methyl choline at a considerable rate. Using the interpretation and nomenclature of Mendel *et al.*[2], it would seem, therefore, that perfused placenta contains a 'true' cholinesterase.

As further evidence of the similarity of this placental enzyme to the true cholinesterase in human brain, we have studied its sensitivity to inhibition by di*iso*propyl fluorophosphonate: the concentration (I_{50}) of this compound required to produce 50 per cent inhibition of the hydrolysis of acetyl choline by the placental enzyme was $1{\cdot}0 \times 10^{-7}\,M$, which agrees well with the I_{50} value of $1{\cdot}3 \times 10^{-7}\,M$ for the enzyme in human brain[3].

By contrast with the 'pseudo-cholinesterase' in human serum, the reaction-velocity of which at different concentrations of acetyl choline accords with the Michaelis–Menten theory, it has been shown that the true cholinesterase exhibits a maximum reaction-velocity at a relatively low substrate-concentration, the rate falling off as this is exceeded[4]; we have also found this to be the case with the placental enzyme, $V_{max.}$ occurring at about 0·0015 *M* acetyl choline.

These findings would seem to indicate that placenta, like the red blood cells, provides a second example of a nerve-free tissue which contains almost exclusively the true cholinesterase usually associated with nervous activity.

We would like to thank Mr. J. B. Blaikley, and the Department of Obstetrics and Gynæcology, Guy's Hospital, for arranging the supply of placentas.

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Revision of Structural Interpretations among Tetrahydrocarbazole Derivatives

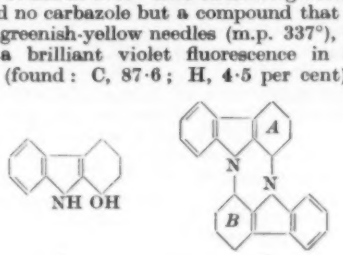
It has already been reported[1] that the action of acids on 9-acetyl-10 : 11-dihydroxyhexahydrocarbazole yields an oxindole instead of a pseudo-indoxyl derivative, and this was confirmed by the synthesis of the latter, found to be identical with the so-called '11-hydroxytetrahydrocarbazolenine'.

Mr. L. J. Goldsworthy has now directly compared Bucherer's product[2] (m.p. 151°) from the dehydration of anilino-*iso*butyric acid with dimethyloxindole prepared from *iso*butyrophenylhydrazide[3] and found the specimens to be identical, as was surmised in our previous note. Independently and simultaneously, these revisions have also been proposed by Witkop[4]. It is necessary, therefore, to state some further conclusions which have been experimentally confirmed.

The action of bromine, followed by that of water, on 9-benzoyltetrahydrocarbazole[5] was found to produce a substance which is now considered to be 9-benzoyl-1-hydroxytetrahydrocarbazole and which certainly yields 1-hydroxytetrahydrocarbazole (I) on hydrolysis. This compound (m.p. 115–116°) was formerly regarded as 11-hydroxy-2 : 3 : 4 : 11-tetrahydrocarbazole. Its true constitution is shown by the fact that it can be prepared along with 1-hydroxyhexahydrocarbazole by the reduction of 1-ketotetrahydrocarbazole with sodium and alcohol. This difficult reduction was first effected in this Laboratory by Mr. B. P. Moore.

On heating with acetic anhydride, and in other ways, 1-hydroxytetrahydrocarbazole suffers facile condensation to the so-called 'dihydrocarbazole' (m.p. 293–295°, recently confirmed) (according to Patrick and Witkop[6], m.p. 255° and 313° after resolidification). On account of its high melting point this substance has long been under suspicion, and the structure II is now attributed to it.

It was found in 1933[7] that on heating with sulphur it yielded no carbazole but a compound that crystallized in greenish-yellow needles (m.p. 337°), and exhibited a brilliant violet fluorescence in benzene solution (found: C, 87·6; H, 4·5 per cent).



I II

That 'dihydrocarbazole' is derived from two molecules of tetrahydrocarbazole has also been recognized by Patrick and Witkop (*loc. cit.*); but the formula given, namely, $C_{24}H_{18}N_2$, is a misprint and should be $C_{24}H_{22}N_2$. The dehydrogenation product mentioned above was stated[7] to be $C_{24}H_{14}N_2$ (requires C, 87·3; H, 4·2 per cent) and it is (II) in which rings (*A*) and (*B*) are benzenoid. The hydroxyl in (I) may be derived by direct replacement of a bromine atom, but it is also possible that it results from an α—γ anionoid rearrangement.

The bromination of tetrahydrocarbazole itself afforded an isomeride of (I) which was considered to be 10-hydroxy-1 : 2 : 3 : 10-tetrahydrocarbazole[8].

This substance (m.p. 153°) is actually the true 11-hydroxytetrahydrocarbazolenine (cf. Patrick and Witkop, *loc. cit.*), and on treatment with nitrous acid and coupling of the resultant diazonium salt with 2-naphthol, it yields an azo-compound (m.p. 143°), which gives analytical results agreeing with the formula $C_{22}H_{20}O_2N_2$, and not $C_{22}H_{18}O_2N_2$.

The above conclusions have been confirmed by a comparison of ultra-violet absorption spectra of the relevant substances and appropriate models.

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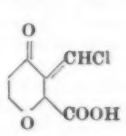
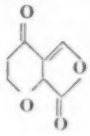
Structure of Chlorodesoxypatulinic Acid

Bergel *et al.*[1] found that the product of the action of ethanolic hydrogen chloride on patulin gave on hydrolysis a crystalline chloro-acid, $C_7H_7O_4Cl$, now called chlorodesoxypatulinic acid. Afterwards, Plattner *et al.*[2] observed that the same acid was readily produced by the action of hydrogen chloride on patulin in moist ethereal solution. The expression (I) was originally deduced[1] for chlorodesoxypatulinic acid from its relationship to patulin, for which the structure (II) was assumed[3]. Recent developments in this Laboratory and in that of Plattner necessitated the abandonment of these views, and led the Swiss group[2] to formulate chlorodesoxypatulinic acid as (III), which was consonant with either of two new structures, (IV)[4] and (V)[5],

put forward for patulin in Cambridge and in Zurich, respectively. We have now accumulated new evidence which requires that (III) in its turn be rejected, and which leads to a new view of the structure of chlorodesoxypatulinic acid which is consistent only with the structure (IV) for patulin.

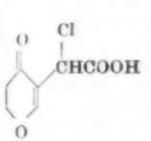


I

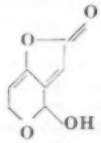


II

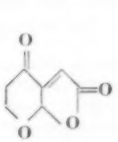
The ester (VI) (m.p. 57–58°) was synthesized in two ways. The ketol (VII)[4] was hydrolysed to the corresponding mono-ester, decarboxylated, and treated with anhydrous formic acid. Alternatively, the product of the condensation of tetrahydro-γ-pyrone with ethyl glyoxylate ethyl hemiacetal in the presence



III

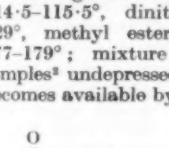


IV

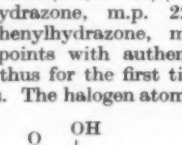


V

of acetic anhydride was treated with anhydrous formic acid. (VI) rapidly consumed one mole of N-bromosuccinimide, and gave an oily bromo-ester, $C_9H_{11}O_4Br$, the properties of which require that it be formulated as (VIII, R = Br). Thus, its infra-red spectrum contained the very characteristic bands of the system .O.C=C.C=O (5·80 μ, 5·98 μ, 6·20 μ), and it was converted substantially quantitatively by hydrogen in the presence of palladium charcoal to ethyl desoxypatulinate (IX, R=Et). Hydrolysis of the latter gave desoxypatulinic acid (IX, R=H) (m.p. 114·5–115·5°, dinitrophenylhydrazone, m.p. 227–229°, methyl ester dinitrophenylhydrazone, m.p. 177–179°; mixture melting points with authentic samples[2] undepressed), which thus for the first time becomes available by synthesis. The halogen atom in



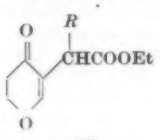
VI



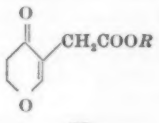
VII

(VIII, R=Br) is very reactive. When the bromo-ester was treated with aqueous silver nitrate, silver bromide was precipitated immediately. With silver acetate, (VIII, R=Br) was smoothly converted to the acetoxy-ester (VIII, R=OAc), characterized as its dinitrophenylhydrazone (m.p. 153–155°). When (VIII, R=Br) was treated with Brady's reagent in ethanol, the dinitrophenylhydrazone (m.p. 181–182°) of the corresponding ethoxy-ester (VIII, R=OEt) was obtained directly. Hydrolysis of the bromo-ester by hot aqueous mineral acids led to a mixture of bromine-free products; no bromine analogue of chlorodesoxypatulinic acid could be detected. When (VIII, R=Br) was treated successively with silver carbonate and thionyl chloride, the chloro-ester (VIII, R=Cl) was formed. This substance possessed an infra-red spectrum very similar to that of ethyl chlorodesoxypatulinate in the double-bond region, but otherwise significantly different. Its ultra-violet spectrum ($\lambda_{max.}$ 262 mμ) confirmed the presence of the system .O.C=C.C=O, but differed slightly in detail from that of ethyl chlorodesoxypatulinate ($\lambda_{max.}$ 270 mμ). The reactivity of the chlorine atom in (VIII, R=Cl) paralleled that of the bromine atom in the analogous ester. Hydrolysis of (VIII, R=Cl) likewise led to halogen-free products, and the action of dinitrophenylhydrazine in acidic ethanol gave an ethoxy-dinitrophenylhydrazone identical with that obtained from the bromo-ester under similar conditions. In sharp contrast, ethyl chlorodesoxypatulinate was smoothly hydrolysed to the parent acid, and gave a dinitrophenylhydrazone in which the chlorine atom was retained. It is now clear that chlorodesoxypatulinic acid cannot have the structure (III), and that its halogen atom must be much more firmly bound than those of (VIII, R=Br) and (VIII, R=Cl).

We have found, further, that chlorodesoxypatulinic acid does not react with silver ion even after a long period, and that it liberates iodine from acidified iodide solutions. These are the reactions of an α-haloketone, and require that chlorodesoxypatulinic acid be assigned the structure (X). Beyond that, it will be clear that the structure (IV) for patulin, *and only that structure*, permits the ready formulation of the changes which lead to (X). Thus, the addition of hydrogen chloride to (IV) gives (XI); the normal

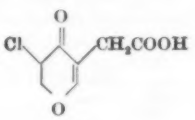


VIII

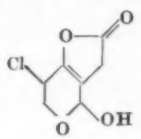


IX

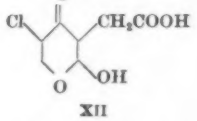
polarity of the system .C=C.O. is reversed by (*a*) the inclusion of the double bond in an α,β,γ,δ-unsaturated conjugated carbonyl system, and (*b*) the attachment of the oxygen atom to a carbonyl group. The β,γ-unsaturated lactone (XI) is then cleaved readily to (XII), which is transformed to (X) by changes which need not be elaborated. In this connexion, it may be noted that α,β,γ,δ-doubly unsatur-



X



XI



XII

ated lactones, as exemplified by patulin and desoxypatulin[4], are much more resistant to hydrolytic cleavage under acidic conditions than simple β,γ-mono-unsaturated lactones.

A further facet of the chemistry of chlorodesoxypatulinic acid is of very considerable interest. When the rigorously purified acid was treated for a short

time with acetic acid–acetic anhydride–sulphuric acid, patulin acetate, identified by melting point (114–116°), mixture melting point (114–116°) and by the identity of its infra-red and ultra-violet spectra ($\lambda\lambda_{max.}$ 277 mμ) with those of the acetate from natural patulin, was formed in *c.* 10 per cent yield. The reaction constitutes a partial synthesis of patulin, and may be considered to involve changes which are in effect the reverse of those described above.

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Jan. 31.

[1] Bergel, Morrison, Moss and Rinderknecht, *J. Chem. Soc.*, 415 (1944).
[2] Engel, Brzeski and Plattner, *Helv. Chim. Acta*, **32**, 1166 (1949).
[3] Ralstrick, Birkenshaw, Michael and Bracken, *Lancet*, **245**, 625 (1943).
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Scintillation Counting of Gamma-Rays

We have investigated the significance of absolute counting-rate in the scintillation measurement of gamma-rays from radium-226, iodine-131, cobalt-60 and sodium-24.

Experiments have been carried out using synthetic crystals of calcium tungstate, chosen for its high density and high absorption coefficient for gamma-rays, in conjunction with a 1*P*21 *R.C.A.* electron-multiplier connected to the crystal via a 'Perspex' light guide. The multiplier tube is cooled in liquid nitrogen. Pulses from the multiplier are amplified (amplifier type 1008: maximum gain 16,000) and led into a scaler (type 1009) incorporating a discriminator. A thin camera shutter and adjustable iris diaphragm placed between the crystal and 'Perspex' rod enables the scintillations produced in the crystal to be distinguished from spurious effects in the light-guide and photo-multiplier. These effects prove to be of great importance at low pulse discrimination.

The intensity of the gamma-radiation at the crystal was estimated in a standard carbon ionization chamber of known absolute calibration. From the theoretical relationship between ionization current and energy flux for gamma-rays of varying energies, the number of quanta falling on the crystal could be calculated. The number of quanta absorbed in the crystal was then estimated from linear absorption coefficients for calcium tungstate, derived from Klein–Nishina, Fowler–Hulme and Heitler theories for scattering, photo-electric and pair-production coefficients respectively. This number of absorbed quanta will correspond to the number of secondary electrons released in the crystal and hence may be related to the observed counting-rate. The secondary electrons will have a range of energies and produce light flashes of varying sizes.

Fig. 1 shows the effects of applying discrimination at various levels to amplifier gain to the pulses produced by cobalt-60 gamma-rays in a crystal of mass 0·330 gm. The results indicate that the counting-rates tend to a maximum limiting value at zero discrimination, the decrease in counting-rate with discrimination being much sharper at low amplification.

Fig. 2 shows the effects of varying the photo-multiplier voltage at zero discrimination and maximum amplifier gain for crystals of equal cross-section but different thicknesses. It will be noted that the counting-rate is approximately constant in the region of highest voltage available. At high pulse-discrimination the counting-rate is, as frequently reported, sharply dependent on photo-multiplier voltage and low amplifier-gain. The measurements appear to indicate that we are observing all the scintillations which set free at least one electron from the photo-multiplier cathode.

Ratio of observed to calculated counting-rates

Mass of crystal (gm.)	0·124	0·330	0·495	0·617
Sodium-24	1·13	0·90	0·80	0·73
Cobalt-60	0·91	0·63	0·52	0·46
Iodine-131	0·79	0·56	0·44	0·39

In view of the small number of photons of visible light per scintillation, the probability of the liberation of an electron would be expected to depend on the optical efficiency of the system. Studies of the effects of varying optical efficiency by adjustment of the aperture of the iris diaphragm confirm this suggestion.

If each secondary electron produces a scintillation and each scintillation at least one electron from the photo-cathode, the counting-rate would equal the rate of production of electrons in the crystal. The accompanying table shows the ratio of counting-rates observed for crystals of different thicknesses and gamma-radiation of varying energies to the calculated number of electrons set free. Extrapolation to zero thickness yields observed and calculated rates in approximate agreement. At finite thicknesses some secondary electrons are not observed owing to the absorption of light quanta in the crystal. The experiments, therefore, show that under appropriate experimental conditions the observed counting-rates in a scintillation counter exposed to gamma-rays have absolute significance, and in calcium tungstate are approximately equal to the number

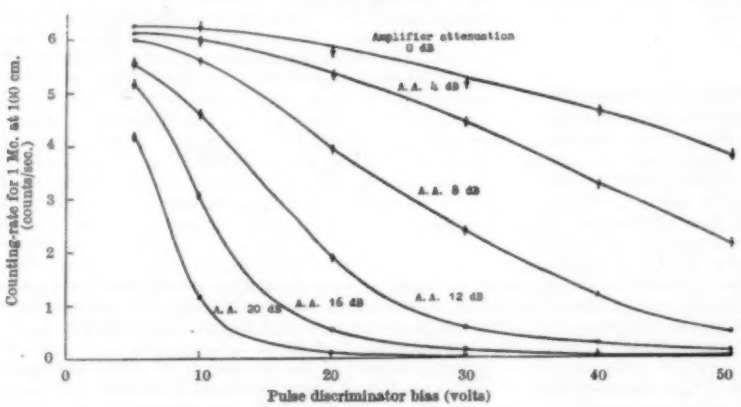

Fig. 1

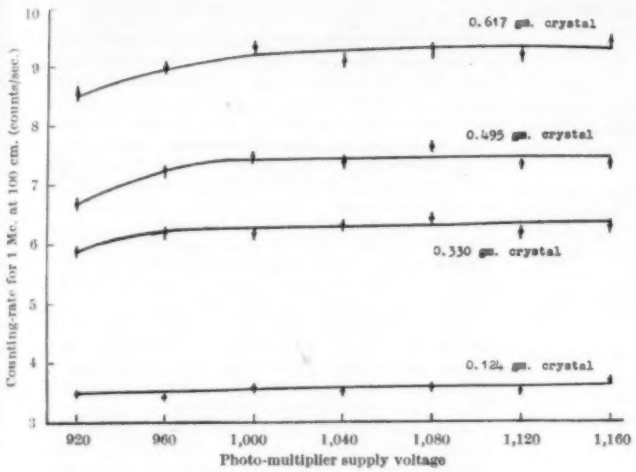

Fig. 2

of electrons set free in the crystal. This result is in accordance with the known approximately 100 per cent efficiency for counting alpha- or beta-particles.

We wish to acknowledge the kindness of Mr. N. Veall, who loaned the synthetic calcium tungstate crystals used, and of our colleague, Mr. W. K. Sinclair, who measured the activity of the radioactive sources.

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[1] Kallman, H., and Broser, I., *Z. Naturforsch.*, **2a**, 439 and 642 (1947).
[2] Moon, R. J., *Phys. Rev.*, **73**, 1210 (1948).
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[4] Jordan, W. H., and Bell, P. R., *Nucleonics*, 30 (October 1949).

A General Method for the Localization of Electronic Transition Frequencies in Continuous Absorption Spectra

The more or less complete lack of vibrational structure in ultra-violet absorption spectra of polyatomic molecules has made it impossible to locate the frequency corresponding to the pure electronic transition. This has further been an obstacle to the semi-empirical development of quantum mechanical theories concerning the electronic structure of complex molecules. In a short communication[1] we have reported some experiments dealing with the temperature effect on the absorption spectrum of *cyclo*-octatetraene. In this connexion we directed attention to a possible method of locating the electronic frequency in continuous absorption spectra.

If we, as a first approximation, assume a smooth thermal Boltzmann distribution over all vibrational and rotational states, and if we further assume that the electronic transition probability is constant, we get the following expressions for the extinction coefficient:

$$\varepsilon = \text{Const.} \times \exp\,(-h(\nu-\nu_0)/kT) \quad \text{for } \nu \leqq \nu_0$$

and

$$\varepsilon = \text{Const.} \quad \text{for } \nu \geqq \nu_0.$$

Here ν is the frequency of the absorbed light and ν_0 the frequency of the electronic line ($0 \rightarrow 0$ frequency).

For the difference between log ε corresponding to two different temperatures (T_1 and T_2) one gets:

$$\Delta \log \varepsilon = \frac{0{\cdot}4343}{k} \times \frac{\Delta T}{T_1 T_2}\,(\nu-\nu_0) \quad \text{for } \nu \leqq \nu_0 \qquad (1)$$

and

$$\Delta \log \varepsilon = 0 \quad \text{for } \nu \geqq \nu_0.$$

The expression (1) represents a straight line passing through the axis ($\Delta \log \varepsilon = 0$) at $\nu = \nu_0$.

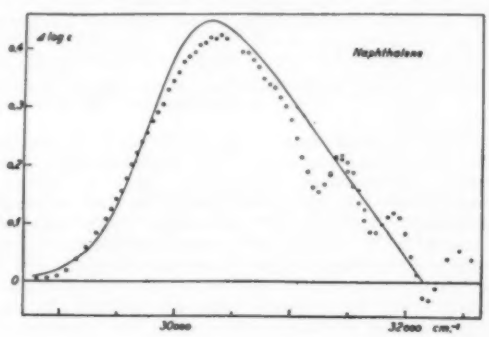
In practice, however, one cannot expect to get a straight line, even if the assumed simplifications should hold, for the following reason. When we pass from ν_0 towards longer wave-lengths in the absorption spectrum, ε decreases exponentially due to the Boltzmann factor. Therefore, even an extremely small amount of an impurity present in the substance under investigation will soon assert itself if it has an absorption in this region. To take this into account (1) has to be modified as follows:

$$\Delta \log \varepsilon = \frac{K_0 c_0 + K_1 c_1 \times \exp\,(-h(\nu-\nu_0)/kT_2)}{K_0 c_0 + K_1 c_1 \times \exp\,(-h(\nu-\nu_0)/kT_1)}, \qquad (2)$$

where K_0 and K_1 are the transition probabilities for the impurity and the substance under investigation respectively, and c_0 and c_1 are the corresponding concentrations.

We have tried this method on the simple aromatic molecules: benzene, naphthalene and anthracene. The accompanying graph shows, as an example, a curve computed from equation (2) for $T_1 = 298°$ K. and $T_2 = 343°$ K., and assuming $\log K_1 c_1 / K_0 c_0 = 4{\cdot}5$, compared with measurements of naphthalene in ethanolic solution. It is seen that the first electronic line may be localized in this way fairly accurately to $\nu_0 = 32{,}150$ cm.$^{-1}$.

Equation (2) may be applied to further electronic transitions appearing at shorter wave-lengths, because each absorption system simply acts as an impurity on the following electronic line.



Using this method, we have located the following electronic transitions :

Benzene	37,850 and 47,100 cm.$^{-1}$
Naphthalene	32,150, 34,700 and 45,200 cm.$^{-1}$
Anthracene	26,650 and 39,700 cm.$^{-1}$

All the determinations were made in ethanolic solutions, and the frequencies given refer to this solution. They may, however, easily be corrected to the vapour state.

If several electronic transitions—as often may be the case—lie close together, the temperature effect will be of a more complicated nature. The results of measurements on *cyclo*-octatetraene[1] and diphenyl may be explained in this way. We are continuing the investigation of this and similar problems of importance for a further development of the general method.

A full account of the work described above will appear shortly elsewhere[2].

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Jan. 28.

[1] *Acta Chem. Scand.*, **3**, 778 (1949).
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Dielectric Deterioration due to Internal Discharges

The effect of discharges in voids enclosed in polythene (Fig. 1*a*), and in voids enclosed between polythene and metal electrodes (Fig. 1*b*), has been investigated using voltages up to twice the discharge-inception voltage at a frequency of 150 kc./s.

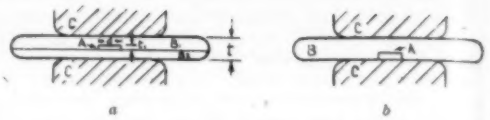

Fig. 1. Sections of circular polythene disks. (*a*) Air-filled cavity (*A*) enclosed between polythene disks (B_1 ; B). (*b*) Air-filled cavity (*A*) between polythene (*B*) and metal electrode (*C*). $t \simeq 0{\cdot}1$ cm. ; $t_1 \simeq 0{\cdot}01$ cm. ; $0{\cdot}05 < d > 0{\cdot}3$ cm.

Initially, discharges cause fairly uniform erosion on the polythene surface, and a transparent resin which fluoresces in ultra-violet light is formed. About 10^{-15} cm.^{3} of polythene is eroded by each discharge of 10×10^{-12} coulombs. This erosion, believed to be a result of thermal degradation, continues for many hours at the discharge-inception voltage ; but at higher voltages the discharge concentrates, after a few hours, near the periphery of the void, forming several deeper pits (Fig. 2). The energy liberated by each discharge in a pit increases with the length of pit, so that erosion progresses with increasing rapidity, and an uncarbonized partial breakdown channel is developed (Fig. 3*a*).

Resin formed in the pits is carbonized when the discharge in the lengthening pits attains a sufficient energy (Fig. 3*b*). When the void is adjacent to a metal electrode, this occurs in shorter pits than when the void is enclosed in polythene.

The mechanism of deterioration is believed to change when the pits attain a critical length ; sharply defined narrow carbonized channels are formed and, in general, rapid breakdown occurs (Fig. 4*b*).

It can be shown by calculation that over a length of some 10^{-4} cm. at the end of the pit, the electric stress may be concentrated to a value approaching the intrinsic electric strength of polythene. It is believed that destruction of the dielectric over this distance is followed by reconcentration of the stress, so that progressive breakdown occurs.

Short-wave radiation generated by the discharge may accelerate the initial deterioration of the polythene and also reduce the ultimate breakdown field-strength.

Fig. 2. Section of polythene disk B_1 (Fig. 1*a*), showing general surface erosion and deeper pits near the periphery of the void after 12 hr. at 11 kV.pk. (2 × discharge inception voltage). × 50

Fig. 3*a*, Section across the largest pit shown in Fig. 2. × 44. Fig. 3*b*. Section across polythene disks (Fig. 1*a*) showing short uncarbonized pits, and carbon at end of longest pits. × 21

Fig. 4*a*. Section across polythene disks (Fig. 1*a*) showing partial breakdown after 8 hr. at 9·7 kV. (2 × discharge inception voltage). × 28

Fig. 4*b*. Section across polythene disk (Fig. 1*b*) showing carbonized channel after 5 hr. at 9·5 kV.pk. (2 × discharge inception voltage). The void was adjacent to a brass electrode. × 45

Tests with polytetrafluorethylene and acrylic resin show that these materials are less resistant to discharges than polythene under equivalent conditions.

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Masses of the π- and μ-Mesons

THE ability to account quantitatively for the observed masses is certainly one of the tests a successful meson theory must meet. Experimental difficulties, however, make precise mass determinations almost impossible; and while a few theoretical attempts have yielded discrete mass values[1], the experimental results are so indefinite as to make most comparisons inconclusive. More than fifty different measured masses, ranging from a few times that of the electron to around 25,000, have been reported by various investigators. In fact, there is some doubt as to whether the masses have unique values.

However, there are two values that are found repeatedly and that lend themselves to a more precise determination. These are the masses of π- and μ-mesons. The best present experimental determinations seem to be 276 and 210 respectively[2]. Their ratio, which is more reliable than the individual mass values, is stated as $1{\cdot}32 \pm 0{\cdot}01$.

Since a satisfactory theoretical prediction of these numbers has not yet been given, it was decided to examine the question from what might be called a pragmatic point of view, in the hope that numerical relations disclosed in this way might suggest the basis for a more definitive theoretical treatment. It was felt that the question of the masses must be bound up in some way with fundamental constants such as $\hbar c/2\pi e^2$ (= 137) and with the properties of space. One notices, first, that the numerical difference of m_π and m_μ is very nearly 137/2 electron masses. Moreover, the formal analogy that appears to hold between the behaviour of photons and electrons on one hand and mesons and nucleons on the other suggests the existence of a 'quantum' of meson mass, corresponding to the quantization of photon energy. This quantum of mass may well be

$$\Delta m = m_\pi - m_\mu = \frac{137}{2} \text{ electron masses.} \quad (1)$$

(In what follows, all masses will be written in terms of the electron mass.)

In addition, it is noted that, with the above numerical values, we can write with very good approximation

$$m_\pi m_\mu = \pi(137)^2. \quad (2)$$

This relation suggests that Δm is, apart from a factor of order unity, the geometric mean of the masses of the two principal mesons. Combining (1) and (2) leads to a quadratic equation determining m_μ:

$$m_\mu^2 + \frac{137}{2} m_\mu - \pi(137)^2 = 0, \quad (3)$$

the positive root of which is

$$m_\mu = \frac{137}{4}\left(\sqrt{16\pi + 1} - 1\right). \quad (4)$$

Also, m_π is given by an equation differing from (3) only in the algebraic sign of the second term. Its positive root is

$$m_\pi = \frac{137}{4}\left(\sqrt{16\pi + 1} + 1\right). \quad (5)$$

Reducing (4) and (5) to numerical values,

$$m_\mu = 211{\cdot}0,\ m_\pi = 279{\cdot}5; \quad (6)$$

and the ratio of the two masses turns out to be

$$\frac{m_\pi}{m_\mu} = 1{\cdot}325, \quad (7)$$

in excellent agreement with present experimental data.

One notices further that the proton mass is given by

$$m_p = 2\pi(\pi - 1)\,(137). \quad (8)$$

The numerical value of this expression is 1843·5, which differs from the best averaged experimental value[3] of 1836·6 by less than four-tenths of one per cent.

Comparison with (4) and (5) brings out the interesting and suggestive relations

$$\frac{1}{m_\mu} - \frac{1}{m_\pi} = \frac{\pi - 1}{m_p}, \quad (9)$$

and

$$m_\mu^2 + m_\pi^2 = \frac{m_\pi^2}{2\pi(\pi - 1)^2}. \quad (10)$$

The possibility exists that all meson masses differ from m_μ (or m_π) by integral multiples of $\Delta m = 137/2$. It would be premature, however, to compare with experimental values until the latter are more accurately known.

It is worthy of note, however, that the smallest positive mass value that can be computed on the Δm basis, namely, $m_\mu - 3\Delta m$, amounts to 5·5. This may be one of the very light mesons for the existence of which Auger and more recently Cowan have found some experimental evidence.

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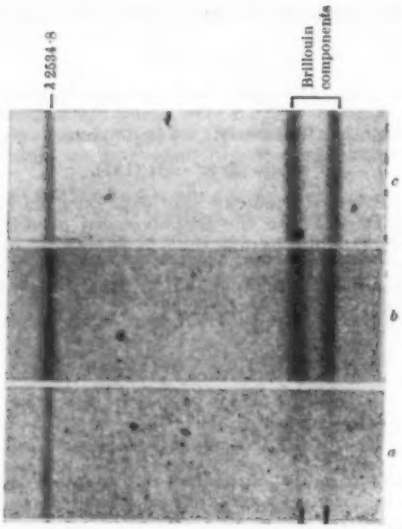
Fine Structure of the Rayleigh Line in Amorphous Substances

As is well known, when monochromatic light scattered by a liquid is examined under high resolution it exhibits a fine structure: an undisplaced central line and two lines on either side with wavelengths slightly different from that of the incident light. The appearance of the displaced components was first predicted by Brillouin[1]. On the basis of his theory, the observed displacements of frequency are regarded as a Doppler effect arising from the reflexion of the light wave by the progressive sound waves of thermal origin in the scattering medium. The frequency shift of the so-called Brillouin components is given by the formula

$$d\nu = \pm\, 2\nu \frac{v}{c} \sin \frac{\theta}{2},$$

where v and c are the velocities of sound and light in the medium and θ is the angle of scattering. That the effect contemplated by Brillouin does arise in liquids and crystals is now a well-established experimental fact.

Both Gross[2] and Venkateswaran[3], who made detailed studies of the fine structure of the Rayleigh



Spectra of the transversely scattered light showing the Brillouin components for: (*a*) fused quartz at 30° C.; (*b*) fused quartz at 300° C.; (*c*) crystal quartz (orientation *YZ*)

line in various media, obtained negative results with glasses. The failure to observe the Brillouin components in amorphous substances has been explained by Gross[4] in the following words: "The undisplaced line of amorphous solids must have, owing to the great stationary inhomogeneities of their structure, a much greater intensity than the displaced components. Being predominant in the spectrum, it may obscure the latter during examination and this is what exactly happens." The use of the λ 2536 radiation and its suppression from the scattered light by absorption in a mercury vapour filter would enable one to observe the Brillouin components, if present, on a clear background[5]. This expectation has been fulfilled, and I have succeeded in photographing the fine structure of the Rayleigh line in fused quartz. The specimen of fused quartz used was in the form of a rod 1 in. in diameter and 3 in. long.

Figs. (*a*) and (*b*) in the accompanying reproduction represent enlarged photographs of the scattered spectra taken with a Hilger three-metre quartz spectrograph and exposures of the order of two days with the fused quartz kept at 30° C. and 300° C. respectively. The exciting radiation (λ 2536) has been completely suppressed from the scattered light by absorption in a mercury vapour filter. The Brillouin components can be seen with difficulty in the spectrum taken at 30° C. The feeble intensity of the scattered spectrum at 30° C. is mainly due to the fact that the fused quartz on exposure to the λ 2536 radiation acquired a slight violet coloration and thereby became less transparent to the ultraviolet radiation. This disturbing effect could be completely eliminated by heating the specimen to about 300° C. In the scattered spectrum taken at 300° C., the displaced components are therefore more clearly seen not only because of their greater intensity at higher temperatures, but also because of the absence of the disturbing effect mentioned above. The Brillouin components in fused quartz appear to be more diffuse and less intense than those observed with crystalline quartz (Fig. *c*). The observed separation of the components in fused quartz is about $\pm$ 1·5 cm.$^{-1}$, whereas the separation calculated from the known value of its elastic constant on the basis of the Brillouin formula is $\pm$ 1·65 cm.$^{-1}$. The agreement is fairly satisfactory.

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Thermodynamic Equilibrium

The modern analytical method in chemical thermodynamics, although in many respects vastly superior to the old method of the isothermal reversible cycle, is unfortunately marred by the absence from standard text-books of a concise and exact statement of the chemical condition of equilibrium. In its place we are offered a number of restricted conditions from which a choice must be made. One of these, for example, is the familiar but not always true statement that for an infinitesimal change at constant temperature and pressure of a system in reversible equilibrium, the change of the Gibbs's free energy is zero ($dG_{T,P} = 0$). Since, however, a single condition of equilibrium which is valid for *any* infinitesimal change may easily be obtained and is, in fact, one of the most important generalizations of thermodynamics, it seems worth while to place it on record.

The surprising absence of an adequate statement of this condition from the literature appears to be largely due to a failure to distinguish between work done against generalized forces within the system (for example, boundary potentials between phases) and work done against generalized forces in the surroundings (for example, an external pressure or electromotive force). Once this distinction is made, the equation for a reversible energy change[1] assumes the form:

$$dE = TdS + \Sigma\mu.dn - (\Sigma X_i.dx_i + \Sigma X_e.dx_e), \quad (1)$$

where E is the total energy, T the absolute temperature, and S the entropy. Also μ is the Gibbs's chemical potential in a given phase of a certain constituent of which n mol. is present in that phase, and the sum $\Sigma\mu.dn$ includes all constituents in all phases. The two terms within brackets represent the work done against all the internal (X_i) and external (X_e) generalized forces respectively as a result of changes in their associated generalized co-ordinates x_i and x_e. For a closed system the principle of conservation of energy obviously requires in addition:

$$dE = TdS - \Sigma X_e dx_e. \quad (2)$$

From these two equations we conclude that the relation

$$\Sigma\mu.dn = \Sigma X_i dx_i \quad (3)$$

must be true for any reversible infinitesimal change of a closed system. This is clearly the general chemical condition for reversible equilibrium, and it is very conveniently given in terms of the chemical

potentials (or forces). It is the most suitable starting point for solving problems in chemical thermodynamics.

The various restricted conditions of equilibrium are all special cases of (3). If required, they may be obtained from it with the aid of well-known thermodynamic relations. Thus from (3) with the aid of (1) we see that the condition for equilibrium for a change at constant S and x_e is given by $dE = 0$. It is not correct, however, to use a restricted condition of equilibrium to obtain (3), since thereby the universal applicability of the latter is obscured. Unfortunately, it is usual even in the best text-books to follow this incorrect procedure and so obtain a simplified version of (3) in the form $\Sigma\mu.dn = 0$, subject to restrictions which have no true basis since they are merely the result of the imperfect method of derivation.

In practice, it is very convenient to consider gram-molecular changes rather than infinitesimal ones, and to assume the system is so large that no appreciable composition changes occur. As is well known, $\Sigma\mu\ dn$ may then be replaced by $\Delta\mu$, the difference between the sums of the chemical potentials for products and reactants when the change is written in the form of a chemical equation. Equation (3), therefore, may assume the more convenient form

$$\Delta\mu = W_i, \qquad (4)$$

where W_i is the total work done against constant internal forces during the change. In either form, the general chemical condition of equilibrium states rather unexpectedly that the chemical forces of a system in equilibrium must always balance the internal generalized forces, independently of whether the internal forces themselves are or are not balanced against corresponding external forces.

As an elementary illustration of these points, consider a galvanic cell composed of two silver – silver chloride electrodes immersed in two different solutions of hydrochloric acid separated by a thin glass membrane permeable only to hydrogen ions. The internal forces operative are the three potentials V_1, V_2 at the electrode surfaces and V_3 across the membrane. The condition of equilibrium is therefore for an infinitesimal change in which the same quantity dq of electricity is carried across each boundary:

$$\Sigma\mu.dn = (V_1 + V_2 + V_3).dq.$$

or for a similar change involving transport of one Faraday (F):

$$\Delta\mu = (V_1 + V_2 + V_3).F.$$

If now the cell is connected to a suitable potentiometer and balanced against an external E.M.F., V_e, physical conditions require $V_e = -(V_1 + V_2 + V_3)$, and since the chemical condition of equilibrium is unchanged, we may write:

$$\Delta\mu = -V_e.F.$$

For any change which involves passage of electricity across, say, the glass membrane only, we have $\Sigma\mu.dn = V_3.dq$, and for changes in which there is no net transport of electricity across a potential barrier $\Sigma\mu.dn = \Delta\mu = 0$. Moreover, if the cell is short-circuited, the sum $V_1 + V_2 + V_3$ must drop to zero, and a new state of equilibrium is eventually reached for which $\Delta\mu = 0$ for a change in which the same quantity of electricity crosses each boundary.

Finally, it is easy to show that a closed system will also be in equilibrium if

$$\Sigma\mu.dn > \Sigma X_i.dx_i,$$

but in this case the equilibrium will no longer be reversible.

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[1] See Fowler and Guggenheim, "Statistical Thermodynamics", 59, equation (222,16).

Effect of a Sudden Ionospheric Disturbance on Long Radio Waves Reflected Obliquely from the Ionosphere

For some time experiments have been in progress in Cambridge to study the characteristics of long radio waves corresponding to frequencies of about 100 kc./s., reflected from the ionosphere at steep incidence, using senders about 100 km. from Cambridge; and recently there has been the opportunity of comparing the behaviour of these waves with that of very similar waves reflected obliquely from the ionosphere using senders about 900 km. distant. This comparison has revealed a number of interesting features, and in particular it has shown up a marked difference in behaviour during the occurrence of a 'sudden ionospheric disturbance'. It is the purpose of this note to describe this difference and to compare the behaviour with that of waves of other frequencies.

The experiments, using radio frequencies near 100 kc./s. at steep incidence, have shown that during 'sudden ionospheric disturbance' there is a marked decrease in amplitude of the reflected wave and a change in its phase corresponding to a decrease in the height of reflexion. This is very similar to the behaviour on much shorter waves (frequencies greater than about 2 Mc./s.), which exhibit the well-known 'fade-out' and, as Findlay[1] has recently shown, also a change of phase.

The experiments at oblique incidence have made use of the senders recently erected in Denmark to provide the Decca system of radio navigation near that country. There are four senders arranged on the standard Decca plan[2], with the master station operating on a frequency of 85·365 kc./s. Continuous records of the signal strength from all four senders and of the phase differences between the master transmission and each of the three slave transmissions are made by the Decca Navigator Company in London using a normal Decca Navigator receiver. I am very much indebted to Mr. W. T. Sanderson, of the Decca Navigator Company, for directing my attention to the existence of these records and for allowing me to make a detailed study of them.

Before this type of record can be interpreted, it is necessary to have an estimate of the relative amplitudes of the ground wave and of the sky wave at the receiving point under normal day-time conditions. This information may be obtained from observations of the 'Hollingworth'[3] standing wave pattern formed

by interference between the ground wave and the sky wave. Measurements of this kind have been made by Williams[4] and by me using receiving apparatus carried in an aeroplane. Both sets of experiments, made on frequencies near 100 kc./s., indicated that the sky wave is relatively small during a summer day and gave the ratio of sky wave to ground wave as about 0·2 at a distance of 900 km. from the sender. This result would correspond to an effective reflexion coefficient of 0·05.

During a 'sudden ionospheric disturbance' the records taken in London on the Danish senders last summer show that there are important changes in amplitude and phase throughout the duration of the disturbance, and on several occasions it has been observed that the total signal falls almost to zero in the course of these changes. Such a marked decrease (of the order of 30 db.) in the resultant amplitude can only occur if the sky wave and ground wave are very nearly equal in amplitude and come into phase opposition. But equality of the sky wave and ground wave implies that the effective reflexion coefficient is about 0·25, or about five times its normal value. The associated phase-change corresponds to a decrease in the height of reflexion.

These experiments indicate that when waves of frequency near 100 kc./s. are transmitted over distances in the neighbourhood of 900 km., the effect of a 'sudden ionospheric disturbance' is to increase the amplitude of the reflected wave and to produce a change of phase corresponding to a decrease in the height of reflexion, whereas when waves of the same frequency are reflected at steep incidence a decrease in amplitude is produced. These large changes in amplitude at oblique incidence have not so far been observed on the highest-frequency slave sender (128·05 kc./s.), which is situated only 725 km. from the receiving site.

It is interesting to compare these results with those on other frequencies. On high frequencies (greater than 2 Mc./s.) there is a decrease in amplitude both for vertical and oblique incidence, and Findlay[1] has shown that there is an associated phase-change corresponding to a decrease in the phase-height of reflexion. On very low frequencies, in the region of 16 kc./s., there is little change in amplitude when the wave is reflected at steep incidence[5,6], but there is a phase change corresponding to a decrease in the reflexion-height; on the other hand, when the reflexion is oblique, there appears to be an increase in amplitude (Bureau[7]).

The conclusions outlined in this note confirm and extend the recent observations of Smith-Rose[8], who has shown that occasionally the downcoming wave on 191 kc./s. observed at a distance of 975 km. is greatly enhanced during 'sudden ionospheric disturbance'.

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Vapour–Liquid Equilibria

Due to the difficulties inherent in the integration of the Gibbs–Duhem equation, very few criteria exist at the present time by which to judge and evaluate vapour–liquid equilibria data, particularly isobaric data.

A useful criterion, applicable to non-associating, non-electrolyte binary systems, has been found. It involves the Li–Coull method of correlating isobaric data[1]; that is, plotting values of $(T \log \gamma_1)^{-0.5}$ and $(T \log \gamma_2)^{-0.5}$ against the mole ratios of the components in the liquid phase. The two straight lines obtained allow four methods to be used to determine the b_1/b_2 ratios mentioned in the above reference, from the relations of the two slopes and two intercepts.

Experimental work has now shown that true equilibria is signified by close agreement of the ratios, as obtained by the four methods. Moderately inaccurate data can even be used to indicate approximately the true values. Fuller details will be published in due course.

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Heart Mechanism of Arthropods

From experiments by several investigators it can be assumed that the heart mechanism of most Crustacea differs from the mechanism of the heart of vertebrates. The heart in Crustacea appears to possess a neurogenic automatism, as has been shown by its reactions to drugs and by histological examination. Not much information exists, however, on the heart in insects.

We have carried out detailed experiments on the isolated heart of *Periplaneta americana* with several drugs and combinations of them. From the action of caffeine, which stimulates the vertebrate heart but inhibits the insect heart, it may be concluded that pacemakers in the vertebrate heart and in the insect heart must be different. This conclusion is supported by the action of digitalin and acetylcholine, which strongly accelerate the insect heart. Strychnine acts on the insect heart as on vertebrate synapses, whereas morphine and apomorphine act in a diphasic manner as on vertebrate nerve centres. These results point to the existence of a neurogenic pacemaker of the insect heart. Experiments with acetylcholine, combinations of this drug with anticholinesterase, and experiments with nicotine, lobeline and pilocarpine (all of which accelerate heart-frequency), suggest cholinergic properties of this neurogenic pacemaker. Atropine, on the other hand, a well-known blocking agent of cholinergic systems in vertebrates, also paralyses the insect heart. Besides cholinergic properties, the heart mechanism of insects possesses adrenergic properties, for it is stimulated by adrenaline and blocked by ergotamine.

Our experiments and the results of former investigators bring us to the conviction that the heart mechanism of most arthropods consists of a neurogenic pacemaker with adrenergic properties, giving off impulses with its own rhythm to the heart muscles. The spontaneous rhythm is controlled by a cholinergic accelerating nerve. This mechanism bears some resemblance to the sympathetic nerve system of

vertebrates, as the neurones of the accelerating nerve act like preganglionic cholinergic units, whereas the neurones of the pacemaker act like postganglionic adrenergic units. Nothing is known, however, about the nature of the inhibitor of the arthropod heart system.

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Fungoid Infection in *Ectocarpus granulosus*

IN a recent communication, Dr. A. A. Aleem[1] has directed attention to a seldom recorded species of phycomycete, *Eurychasma Dicksoni* (Wright) Magnus, which was found near Plymouth parasitizing *Ectocarpus granulosus* Agardh. During the spring and summer months of 1945, 1946 and 1947, I observed this fungus on a number of occasions infesting *E. granulosus* that had colonized test panels suspended in the sea from a raft at Millport, Isle of Cumbrae. These panels were immersed at a constant depth of two feet in a fairly sheltered and fully marine environment.

The main period of *Ectocarpus* settlement and growth on panels at this site extends from March to September and includes the species *E. granulosus*, *E. Hinksiæ* Harvey, *E. Sandrianus* Zanard, *E. confervoides* Le Jol and the closely related *Pilayella littoralis* Kjellm. There was no indication that the fungus was affecting the general seasonal picture, nor was it recorded from any other species of *Ectocarpus*.

I am indebted to Miss Jane L. Smith for confirming the identity of *E. granulosus*.

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'Let-down' of Milk in the Sow

A CONSIDERABLE amount of work has been carried out in recent years on the problem of the 'let-down' of milk in the cow; but, so far as we are aware, nothing has been published on any such work on the sow. From the lactational point of view, the sow differs from the cow in several ways; she has, for example, an exceptionally strong control over the release of her milk. While the normal cow lets down her milk easily, it is normally impossible to obtain by hand any milk from the sow unless let-down is first artificially induced by the intravenous injection of an extract of the posterior pituitary lobe[1]. In addition, it is necessary to rope the sow during the process of obtaining the milk, and consequently the condition of co-operation which normally exists in the routine milking of the cow does not obtain.

A preliminary experiment has just been completed with the object of determining whether a yield and time of milk-flow response could be established for four different doses of oxytocin, namely, 1, 3, 5 and 10 units ('Pitocin', Parke, Davis and Co.).

Four gilts were used, and each was injected daily, six times a week over a period of four weeks, commencing on the eighth day of lactation. Each gilt, therefore, received a total of twenty-four injections, six of each of the above four doses. The various doses were randomized in order to discount for any trend in milk-yield due to advancing lactation. Each day, after a natural suckling had been completed, the litter was removed, and the 'artificial' milking was carried out two hours later. The two front teats only were milked. The results are summarized in the accompanying table.

Dose (units of oxytocin)	1	3	5	10
Yield of milk/udder (ml.)	41	78	82	104
Time of milk flow (sec.)	80	131	135	179
Rate of flow of milk (ml./min.)	31	36	36	35
Fat and solids-not-fat % Fat	7·02	7·54	7·51	7·34
S-n-f	10·76	10·82	10·87	10·80
Time between end of injection and start of milk flow (sec.)	11·6	11·2	10·3	9·9

All the figures in the table are means of 48 readings, except those relating to fat and solids-not-fat, which are means of 24 readings. At each milking the milk from the two glands was bulked before a sample for analysis was taken. (We are indebted to Dr. S. J. Rowland for carrying out the analysis.)

The results indicate that, under the conditions of the experiment, the amount of milk a sow releases is related to the concentration of oxytocin in the blood. The length of time of the flow of milk appears also to be related to the amount of this hormone in the blood.

The range of the figures for fat and solids-not-fat in the samples obtained was too wide for any conclusions to be drawn as to average composition, and further work is required to determine whether the composition of the milk is in any way related to the amount obtained. Further experiment is also required to determine whether there is any correlation between the rate of flow of milk and the amount of oxytocin in the blood.

These results justify further investigation into the let-down phenomena in the sow, and experiments on a number of problems are planned. Those in progress deal with (*a*) the establishment of a dose, and time of flow, response to the administration of very small quantities of oxytocin, (*b*) investigations into the response to large doses of oxytocin (larger than 10 units), (*c*) correlation of the amounts of milk obtained by piglets when suckling with those obtained by hand milking after the artificial induction of let-down. A full report of these investigations will be published elsewhere.

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Aryloxyaliphatic Acids as Systemic Fungicides

A SYSTEMIC fungicide may be defined as a fungicidal compound which is readily translocated as such in the plant, rendering the tissues penetrated toxic to fungi. It is immaterial whether the fungus is killed at the point of penetration or not, for the toxic effect of a fungicide depends on its concentration, and a compound does not cease to be a fungicide because it is present in sublethal amounts. Outstanding work on the treatment of vascular disease, in particular Dutch elm disease, by compounds translocated in the host has been carried out by Horsfall[1] and his

associates; more recently, McNew and Sundholm[3] have shown that leaf injection with certain 4-nitrosopyrazoles will significantly reduce infection with *Alternaria solani* on tomato, clearly indicating a systemic action.

There are two obvious starting points in a search for a systemic fungicide: to survey known fungicides for systemic properties, or to examine the effect on fungi of compounds known to be translocated by higher plants. In the present series of trials the second line of approach was chosen, and the aryloxyaliphatic acids, many of which are known to be translocated readily and which have been shown to possess some fungicidal activity[1], were examined.

Earlier work on the toxicity of aryloxyaliphatic acids to *Nectria galligena* Bres. in connexion with the treatment of apple canker[1] has led to the following general conclusions: (1) naphthoxy-acids are in general more fungicidal than phenoxy-acids; (2) there is little difference in toxicity between the acetic and α-substituted propionic acids, but the β-substituted propionic acids are far more toxic; (3) increasing chlorine substitution in the nucleus gives greater toxicity.

Apple canker is an unsuitable disease for work with systemic fungicides, and in the present series of trials the compounds were tested against *Botrytis cinerea* infection of broad bean (*Vicia faba*). Laboratory tests showed that the toxicity of the substance to *B. cinerea* followed the same pattern already demonstrated for *N. galligena*, towards which forty-five aryloxyaliphatic acids have been assayed. Acids were selected for examination as systemic fungicides on the basis of their toxicity to *N. galligena*; but those compounds producing drastic modifications in the development of the plant were avoided.

Most of the present trials have been carried out on young bean seedlings grown for two or three weeks with their roots immersed in solutions containing 10 p.p.m. of the acid; but, in addition, the stems of larger potted plants have been injected with solutions of the same strength. After treatment, the plants were sprayed with a heavy suspension of spores of *B. cinerea* and kept in a saturated atmosphere until symptoms had developed, usually after three days; the damage to each leaf was then assessed on an arbitrary scale.

2 : 4 : 6-Trichlorophenoxyacetic acid produced a consistent reduction in disease. In five independent trials with seedling beans, the mean percentage reduction recorded was 36 per cent with a standard error of 7 per cent. In these experiments the mean fresh weight of the tops of control plants was 5·5 gm.; treatment caused some retardation in growth with a reduction of about 17 per cent in fresh weight. So far as could be judged, the effect of treatment was to check the spread of the individual lesions rather than to prevent lesion formation.

In addition, the following acids have produced significant reduction in disease-rating in preliminary trials: pentachlorophenoxyacetic acid, pentachlorophenoxy*iso*butyric acid, and α-(2-naphthoxy)-phenylacetic acid. None of these compounds has caused serious damage to the plants at the concentrations used.

2 : 4 : 5-Trichlorophenoxy*iso*butyric acid produced some reduction in disease when injected into the stem, but roots immersed in solutions of the acid became severely damaged and the treated seedlings showed no reduction in disease. In view of its marked activity in fungicidal tests, the results with β-(2 : 4-dichlorophenoxy)-propionic acid have been disappointing, but it is possible that this and similar compounds are broken down too rapidly by β-oxidation to the corresponding phenol[4] for translocation to occur.

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Dispersal of *Amœba proteus*

It is well known that encysted amœbæ of various species can withstand complete desiccation and so be dispersed to a new environment; but not until recently has this possibility been tested out on *Amœba proteus*, a species largely used for educational purposes. Since 1916, cultures of *Amœba proteus* have been maintained in this laboratory. We have now been able to demonstrate that a culture of encysted young *Amœba proteus* will recover after it has been allowed to dry up completely.

The experiment was conducted in the following way. A new culture from pedigree Killarney stock was started in a black plastic receptacle (6·5 in. × 3·5 in.) and covered with a glass lid on September 28, 1948. This culture, entered in the field book as 102*a*, was allowed to go through the normal cycle of fission in which all the adult amœbæ were dividing into two on an average at intervals of one to three days. In due course there ensued a depression cycle in which all the aged individuals were forming encysted young. To initiate this, the nucleus of each adult becomes converted into chromidia which migrate into the cytoplasm and there organise the formation of hundreds of encysted young. By May 6, 1949, there were no adult amœbæ visible in culture 102*a*, so the assumption was made that encystment had taken place.

The culture was then left without a lid and the liquid was allowed to evaporate very slowly until, on August 17, 1949, nothing was left except a thin layer of greenish dust. Water was added to this and the receptacle was again covered with a glass lid. Examination of this a few days later revealed nothing living. On August 26, 1949, there were visible a few live flagellates and ciliates. On December 7, 1949, these had multiplied to form a rich culture of the food organisms, including rotifers, favoured by *Amœba proteus*. On January 19, 1950, young amœbæ were present and it became clear that the culture was re-establishing itself. At the time of writing many young adults as well as developing young are present, thus demonstrating the fact that *Amœba proteus* in the young encysted stage can survive desiccation and is thus capable of dispersal by wind or other agencies.

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The *MNS* Blood Groups of Australian Aborigines and New Guinea Natives

THE antigen *S* is part of the *MN* system of blood groups; it bears the same relation to *M* and *N* as does *C* to *D* and *d* in the *Rh* system of groups. In England, 54·69 per cent of people have the antigen *S*; and the gene frequencies are[1]: *MS*, 0·2472; *Ms*, 0·2831; *NS*, 0·0802; and *Ns*, 0·3895.

The antigen *S* is absent from the blood of Australian aborigines. The following are the groups of 178 unrelated and allegedly full-blooded aborigines from Bathurst Island in Northern Territory and from Cherbourg and Woorabinda in Queensland:

MsMs	*MsNs*	*NsNs*	Total
14	63	101	178
7·87	35·39	56·74	100·00

The gene frequencies are: *Ms*, 0·2556; and *Ns*, 0·7444.

In the blood of New Guinea natives, however, the antigen *S* is present. It was found in 22·7 per cent of 141 samples which had the following distribution:

MM.S	*MsMs*	*MN.S*	*MsNs*	*NN.S*	*NsNs*	Total
1	7	13	30	18	72	141
0·71	4·96	9·22	21·28	12·77	51·06	100·00

The gene frequencies are approximately *MS*, 0·0522; *Ms*, 0·1489; *NS*, 0·0843; and *Ns*, 0·7146. It can be calculated that 26 per cent of the *M* genes are *MS*, and 10·5 per cent of the *N* genes are *NS*. This ratio of 2·5 to 1 is close to that found in England, namely, 2·8 to 1.

It is of interest to note that the anti-*S* serum makes such a sharp distinction between Australian aborigines and New Guinea natives, while anti-*M* and anti-*N* alone show but little difference between these two anthropologically distinct groups.

A fuller account of this work will be published elsewhere, together with the results of tests for *ABO*, *Rh*, *P*, *Lewis*, *Kell* and *Lutheran* groups.

RUTH SANGER

Red Cross Blood Transfusion Service,
374 George Street,
Sydney.

[1] Race, R. R., and Sanger, Ruth, "Blood Groups in Man" (Blackwell Scientific Publications, Oxford; in the press).

Soviet Genetics: the Real Issue

PROF. NUZHDIN[1] states that in the U.S.S.R., "Morganism [neo-Mendelian genetics] is being routed as a reactionary trend in science", that it is "against the people", and more to the same effect. This appears to be a complete admission of the truth of my general thesis, namely, that in the U.S.S.R. Mendelian genetics has been officially repudiated and declared untrue not on scientific but on political or ideological grounds.

It is difficult to discuss the matter with someone who believes that "capitalist science" is something different in its nature and methods from Soviet (communist) science, and "cannot be objective"; or indeed that any branch of natural science can be "reactionary". A reactionary use may be made of its facts or principles; but the facts and principles are ethically and politically neutral, while if we believe that the discovery of new material knowledge is in itself a good, and an indispensable tool for possible human progress, then any branch of science which adds to knowledge must *per se* be progressive.

One of the most remarkable scientific achievements of this century has been the discovery that the main (and probably almost the sole) organ of heredity throughout living organisms is the gene-complex in the chromosomes, capable of self-copying but also of the occasional variation known as mutation; the variants are therefore subject to differential reproduction as an automatic result of natural selection; and this in turn is the main (and probably almost the sole) agent of evolutionary change.

This was made possible by the combined efforts of biologists in every scientifically advanced country, including the U.S.S.R., and of every class and political persuasion, including Communism. It is now established scientific knowledge, and will remain so whether heritable variations can sometimes be directively induced, whether they can be induced by "graft-hybridization", what the precise chemical composition and structure of the genes may be, etc. It is just as well established as the fact that the organ of vision in vertebrates is the eye, with its main receptor system composed of rods and/or cones in the retina. The fact that the organ of heredity is the gene-complex and the organ of vision is the eye are facts of Nature, and cannot be either reactionary or progressive. "The interests of the people" cannot alter the fact of the existence of gene-complexes in the people's chromosomes, any more than they can alter the fact that the earth is spheroidal and follows an elliptical path round the sun. And yet Lysenko, in his 1948 Report, actually referred to "Morganism" as "a pseudo-science".

If racists and anti-democratic eugenists have endeavoured to bolster up their views with the aid of Mendelism, this again does not prevent the facts of Mendelism from being true, or prove Mendelian genetics to be reactionary. Propagandists will use what material they can find: the late Prof. MacBride justified his very reactionary eugenic views not on Mendelian but on Lamarckian grounds.

Prof. Nuzhdin says that Morganism is being attacked in the U.S.S.R. as reactionary because "its theoretical postulates lead to [certain] conclusions", for example, that "in man the bad genes are spread among the broad masses of working people, also among Negroes, Jews, Malayans, etc.", and that accordingly "Morganism recommends . . . sterilization".

This is, to start with, untrue. Mendelism does not start from any theoretical postulates: it has built up certain theoretical principles inductively on the basis of a large number of experimentally ascertained facts. Secondly, it has never asserted that working people, Jews, etc., necessarily contain an undue proportion of "bad genes". Thirdly, Morganism "recommends" nothing, any more than does the atomic theory of matter. Further, the existence of inequality of genetic endowment among human individuals is a fact; but neither this, nor the genetic inequality of human groups if it were ever proved, can prevent the existence of chromosomal gene-complexes as a fact of Nature.

It is quite possible that we shall discover how to produce directed variation experimentally, as we have already produced undirected mutation, and that treatments such as grafting may exert a permanent genetic effect (though so far all attempts to

reproduce the results claimed by the Russians have failed). But any such new discoveries, we can be perfectly sure, will involve not the overthrow of neo-Mendelian genetics, but its fruitful extension.

Prof. Nuzhdin is responsible for the statement that "Huxley . . . is forced to serve a definite purpose, his masters dictate their will to him. To oblige them he published his slanderous article against the Soviet Union" [sic]. It is probably enough to direct the attention of readers of *Nature* to the fact that a responsible man of science can make such astonishing, false and unsupported allegations. But I take this opportunity to state publicly that no individual or organisation even suggested, much less urged or ordered, that I should write anything on the subject; that, apart from the standard rate of payment made by *Nature* to its contributors and the customary royalty arrangements with my publishers, I have received no fee or payment for writing my articles or book on the subject; that my only salaried employment since 1942 has been in the service of an international agency of the U.N. (Unesco); and that I wrote the articles at Naples before returning to Great Britain from the Unesco Conference in Lebanon.

In conclusion, I wish emphatically to deny Prof. Nuzhdin's statement that my attitude towards the Lysenko controversy is dictated by anti-Soviet bias or that "it is just another link in the general campaign which the reaction is waging against the Soviet Union". In point of fact, I have always been highly appreciative of the achievements of Soviet science in general (see my little book, "A Scientist Among the Soviets" (1932)); and my article on the state of biology in the U.S.S.R. in 1945, in *Nature*[2]. What I have been concerned about are the methods, shocking to free men of science, which have been employed to proscribe a branch of science on ideological grounds. I must refer readers to my book "Soviet Genetics and World Science" (1949) for confirmation and for the lurid and almost incredible details.

JULIAN HUXLEY

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Hampstead,
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[1] *Nature*, **165**, 704 (1950).
[2] *Nature*, **156**, 254 (1945).

Technological Education in Great Britain

NUMEROUS documents and articles have discussed the difficult problem of technological education in Great Britain, and it is remarkable that few contributions have appeared from the technical colleges. Indeed, some statements betray a complete ignorance of what is being done in major colleges of technology. At the conference held in the Royal Society's rooms on March 27 (see *Nature*, April 22, p. 627), the views of only one principal of a technical college are mentioned, whereas many associated with the universities are quoted. It is this omission that has prompted me to write this letter. In a leading article in *Nature* of May 13, p. 737, it is stated that "the question of higher technological education lies right outside the field of technical colleges in general, as at present constituted. Their function is essentially the provision of the vastly greater number of technicians which industry also requires; and to equip and staff them essentially for the training of technologists would impede the performance of their primary function."

The words "in general" possibly limit the application of this statement, although how is not clear. It is true that the majority of technical colleges in Great Britain come within the category mentioned above; but some of the major colleges of technology do not. It is the failure to appreciate that those few (the Percy Committee suggested twenty-seven) colleges of technology are providing education mainly for the technologists and not for technicians that leads to endless confusion. These major colleges of technology have three-, four- and five-year full-time courses in operation which are often of university degree standard in content and attainment, and they are attended by large numbers of students. These are the colleges which should be included in any discussion on higher technological education, for the courses in these colleges are founded on research and, where appropriate, on basic science. Most of the colleges do not provide courses for technicians to any greater extent than the universities and university colleges.

A further problem is presented by the establishment of 'national colleges' which will undertake the most advanced work and research in a technology. For example, a National College of Rubber Technology (of which I am director) is being financed from Government funds through a Ministry of Education scheme, and some of its work will be associated with the Northern Polytechnic. It is highly undesirable that Government or other funds should be wasted in creating an exactly similar establishment under the University Grants Committee. Assuming rubber technology to be a suitable subject for a first-degree award—degrees in many similar technologies are already awarded in universities—can it be justly contended that because the courses are established under a Ministry of Education scheme, the students are necessarily unsuitable for, and are to be deprived of the chance of obtaining, a first degree or a truly equivalent qualification?

The few major colleges of technology I have in mind are providing higher technology, worthy of a degree or equivalent award. The students have full social and athletic facilities which compare favourably with those in the universities. The staffing is comparable, although the recent increase in university salaries without a corresponding increase in the salaries in colleges of technology has embarrassed the latter, who are now losing their staffs to the universities. Like the universities, they could, of course, be improved. However, their facilities should be used and developed to the full, either by affiliation with the university scheme or by having available a national award equivalent to a degree. Possibly what is more important, these colleges should not be ignored in discussions on higher technology. Most of the views expressed in the article in *Nature* are as acceptable to the colleges of technology as to the universities; but it must be appreciated that these colleges of technology are not technical colleges established primarily for the equally important function of training technicians. They are not offering technicians' courses, and would require complete reorganisation if they were to change from higher technological education to instruction of technicians.

T. J. DRAKELEY
(Principal)

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FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, June 10

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Discussion on "A Memorandum on the Design of Mine Workings to secure Effective Strata Control".

Monday, June 12

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Discussion on "Some Philosophical Problems of Cosmology".

Tuesday, June 13

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Mr. C. Ovey: "Foraminifera".

Wednesday, June 14

PHYSICAL SOCIETY, COLOUR GROUP (in the Lecture Room, Institute of Ophthalmology, Judd Street, London, W.C.1), at 5.30 p.m.—Dr. L. C. Thomson: "Foveal Colour Sensitivity".

Thursday, June 15

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. F. M. Burnet, F.R.S.: "The Interaction of Virus and Cell-Surface" (Croonian Lecture).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr. J. C. Burkill: "Integrals and Trigonometric Series".

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Annual General Meeting; Dr. Frank Hawking: "Some Recent Work on Filariasis".

Friday, June 16

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. J. L. Cowan: "A Survey Flight to South Africa"; Mr. Michael Townsend: "Light Aircraft Navigation".

MEDICAL RESEARCH COUNCIL (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Prof. A. C. Burton (University of Western Ontario): "Clothing and Heat Exchanges in the Human Body".*

Saturday, June 17

BIOCHEMICAL SOCIETY (in the School of Biochemistry, Tennis Court Road, Cambridge), at 11 a.m.—Scientific Papers.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DEMONSTRATORS IN THE DEPARTMENT OF BIOLOGICAL SCIENCES IN (*a*) BOTANY, (*b*) ZOOLOGY—The Registrar, Wye College, Wye, Ashford, Kent (June 17).

HEAD OF THE DEPARTMENT OF TEXTILE INDUSTRIES in the Technical College, Bradford—The Director of Education, Town Hall, Bradford (June 17).

JUNIOR ASSISTANT PHYSICIST (with good physics degree) for work on X-rays, radium and radio-isotopes—The Secretary, University College Hospital, Gower Street, London, W.C.1 (June 17).

LECTURER IN METALLURGY—The Registrar, King's College, Newcastle-upon-Tyne (June 17).

PRINCIPAL EXECUTIVE ASSISTANT IN THE DEPARTMENT OF THE CHIEF DEVELOPMENT AND RESEARCH OFFICER—The Staff Officer (Ref. F/EV.136), London Transport Executive, 55 Broadway, London, S.W.1 (June 17).

SENIOR ASSISTANT IN THE DEPARTMENT OF CHEMISTRY AND BIOLOGY, Leeds College of Technology—The Chief Education Officer, Education Office, Leeds 1 (June 17).

TEACHER OF CHILD PSYCHOLOGY at Queen's University, Kingston, Canada—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (June 17).

RESEARCH STUDENTSHIPS IN (*a*) ENGINEERING and (*b*) METALLURGY—The Registrar, University College, Singleton Park, Swansea (June 21).

DEMONSTRATOR IN AGRICULTURAL CHEMISTRY—The Registrar, The University, Leeds 2 (June 24).

LECTURER or SENIOR LECTURER IN THE DEPARTMENT OF HUMAN ANATOMY, University College of the West Indies—The Secretary, Senate Committee on Higher Education in the Colonies, University of London, Senate House, London, W.C.1 (June 24).

SENIOR LECTURER or LECTURER IN PHYSIOLOGY, and an ASSISTANT LECTURER IN PHYSIOLOGY—The Registrar, The University, Sheffield (June 24).

LECTURER IN MATHEMATICS (specially qualified in either Pure or Applied Mathematics)—The Secretary, The University, 38 North Bailey, Durham (June 26).

ASSISTANT LECTURER (temporary) IN AGRICULTURAL ZOOLOGY—The Secretary and Registrar, University College of North Wales, Bangor (June 30).

PRINCIPAL SCIENTIFIC OFFICERS (Ref. F.320/50A) to take charge of a section dealing with a group of products, entailing chemical and technical investigation of the raw materials, etc., SENIOR SCIENTIFIC OFFICERS (Ref. F.321/50A) to carry out chemical and technical investigations of plant and animal products, etc., SCIENTIFIC OFFICER (Ref. F.322/50A) to assist in the duties under Ref. 321/50A, SENIOR EXPERIMENTAL OFFICER (Ref. F.323/50A) to assist in carrying out chemical and technical investigations of plant and animal products, etc., and ASSISTANT EXPERIMENTAL OFFICERS (Ref. F.324/50A) to assist Experimental Officers in the duties under Ref. F.323/50A, at the Colonial Products Advisory Bureau (Plant and Animal), Imperial Institute Building, South Kensington, London, S.W.7—The Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 1).

SENIOR RESEARCH OFFICER or RESEARCH OFFICER (Bacteriologist-Biochemist) (Ref. No. 2873) in the Dairy Research Section at the School of Dairy Technology, Werribee, Vic., a RESEARCH OFFICER (Ref. No. 2871) in the Section of Meteorological Physics, Melbourne, and a RESEARCH OFFICER (Ref. No. 2872) in the Coal Research Section, Sydney, of the Commonwealth Scientific and Industrial Research Organization—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 1).

SENIOR LECTURER and a LECTURER IN PRODUCTION ENGINEERING in the Department of Technical Education of New South Wales—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (July 8).

MECHANICAL ENGINEERS (Ref. C.267/50) with research and development experience in light mechanisms, ELECTRICAL ENGINEERS (Ref. D.152/50) or PHYSICISTS (Ref. A.146/50) with research and development experience in light electrical mechanisms, electronics or acoustics, in Senior Experimental Officer and Experimental Officer grades at Admiralty Experimental Establishments—The Secretary, Ministry of Labour and National Service, Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (July 20).

PRINCIPAL OF THE VICTORIA UNIVERSITY COLLEGE, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (July 31).

SENIOR LECTURER or LECTURER IN MATHEMATICS at the University of Sydney—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Sydney, July 31).

ASSISTANT CONSERVATOR OF FORESTS in the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Conservator of Forests'.

HONOURS GRADUATE in chemistry or biochemistry (preferably with some postgraduate research experience) as Scientific Officer to undertake research on enzymes—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

INVESTIGATOR (preferably with an honours degree in metallurgy or physics) to study stretcher-strain phenomena, an INVESTIGATOR (preferably with an honours degree in metallurgy) to carry out large-scale experimental work on the extrusion of lead, and a RESEARCH ASSISTANT to assist in a study of hot dip galvanizing—The Secretary, British Non-Ferrous Metals Research Association, Euston Street, London, N.W.1.

PHYSICIST or PHYSIOLOGIST specially qualified in physics, to undertake work on climatology and on metabolism of farm animals—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

SOIL CHEMIST IN THE RESEARCH DIVISION of the Ministry of Agriculture, Sudan—The Sudan Agent in London, Wellington House, Buckingham Gate, London, S.W.1, endorsed 'Soil Chemist'.

REPORTS and other PUBLICATIONS

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Great Britain and Ireland

Industry and a Minimum Wage, by Dr. J. J. Mallon; Universities and Management, by Lord Lindsay of Birker. Pp. 23. (London: British Institute of Management, 1950.) 2*s.* 6*d.* [153

Statement on Defence, 1950. (Cmd. 7895.) Pp. 14. (London: H.M. Stationery Office, 1950.) 4*d.* net. [153

Memoirs of the Geological Survey—Scotland. Geology of Central Ayrshire. By V. A. Eyles, Dr. J. B. Simpson and Dr. A. G. MacGregor. Second edition, with Contributions by Dr. J. E. Richey; Palaeontology, by F. W. Anderson. Pp. 160+8 plates. (London: H.M. Stationery Office, 1949.) 7*s.* 6*d.* net. [163

British Museum (Natural History). Great Barrier Reef Expedition, 1928–29. Scientific Reports, Vol. 5, No. 7: Actiniaria and Coralimorpharia. By Oskar Carlgren. Pp. 427–457. (London: British Museum (Natural History), 1950.) 7*s.* 6*d.* [163

Ministry of Agriculture and Fisheries. Bulletin No. 144: Bee-Hives. By Dr. C. G. Butler. Pp. ii+20+4 plates. (London: H.M. Stationery Office, 1949.) 9*d.* net. [163

Philosophical Transactions of the Royal Society of London, Series B: Biological Sciences. No. 611, Vol. 234: A Revision of the Zoantharia Rugosa in the Light of their Minute Skeletal Structures. By Dr. H. C. Wang. Pp. 175–246+plates 4–9. (London: Cambridge University Press, 1950.) 24*s.* [233

British Standard 942: 1949, Formulae for Calculating the Intensities of Lighthouse Beams and Beams from Cognate Projection Apparatus. Pp. 40. 7*s.* 6*d.* net. British Standard 1627: 1950, Cold Drawn Low Carbon Steel Tubes for Heat Exchangers and Condensers for the Petroleum Industry. Pp. 8. 2*s.* net. British Standard 1628: 1950, Cold Drawn Alloy Steel Tubes for Heat Exchangers and Condensers for the Petroleum Industry. Pp. 8. 2*s.* net. British Standard 1634: 1950, Dimensions for Stoneware Pipes and Pipe Fittings for Chemical Purposes. Pp. 24. 2*s.* 6*d.* net. (London: British Standards Institution, 1949–1950.) [233

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Science Museum. Outline Guide to the Exhibits. Pp. 36+6 plates. (London: H.M. Stationery Office, 1950.) 6d. net. [283

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Concrete Simply Explained. By Victor S. Wigmore. Third and revised edition. Pp. 53. (London: Society of Engineers, 1950.) 2s. [283

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Science Museum. The Science of Weather: an Exhibition held at the Science Museum, London, to mark the 100th Birthday of the Royal Meteorological Society in 1950. By D. Chilton. Pp. 32+8 plates. (London: H.M. Stationery Office, 1950.) 1s. net. [303

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